

SALT CONTAMINATION OF PRIVATE WELL WATER SUPPLIES

Village of Stittsville

1973

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Ontario

Ministry
of the
Environment

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Minister

Everett Biggs,
Deputy Minister

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MINISTRY OF THE ENVIRONMENT

VILLAGE OF STITTSVILLE

SALT CONTAMINATION

OF

PRIVATE WELL WATER SUPPLIES

BY

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1973

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CONTAMINATION OF PRIVATE WELL WATER SUPPLIES

VILLAGE OF STITTSVILLE

1. INTRODUCTION

In response to a request from Mr. N. LaBarre, Sanitary Engineering Branch, Ottawa, an investigation was undertaken by the Water Quantity Management Branch to determine the source of salty water in a large number of private wells in the Village of Stittsville. The general location of the study area is shown in Figure 1. A more detailed map of the area is presented in Figure 2.

The study included an office examination of the hydrogeology, physiography and water-well records for the area. Water samples were collected from approximately 40 wells in the area on 11 occasions over a period of 22 months. The results of the chemical analyses of samples collected during this investigation are shown in Table 1. Water well and sampling locations are shown in Figure 2.

After determining the source of the salt in local well waters, recommendations to stop the salt contamination of the aquifer were implemented followed by an extended sampling program to determine the time necessary for the aquifer to return to background quality. The results of this extended study are beyond the scope of this report and will be summarized upon the completion of the investigation.

2. BACKGROUND

In approximately 1965 a large housing development was initiated in the study area utilizing private wells as the source of water supply. The water quality in the individual wells was reported to be fresh at the time of drilling. However, in time, the water from most of the wells developed a salty taste and the matter was brought to the attention of the Sanitary Engineering Branch. As will be shown, chloride concentrations in the study area vary from 55 ppm upgradient to a recorded high of 2252 ppm downgradient from the storage facilities. During the study, undesirable nitrate concentrations were found to be present in many of the wells. The suspected source of the contamination was nearby road-salt storage facilities.

In November, 1967 and 1960 salt and sand storage facilities were established in the study area for the Township of Goulbourn and the Regional Municipality of Ottawa-Carleton, (former County of Carleton), respectively. The township yard is

not paved and salt has never been stored under cover in this yard. The regional yard is paved but no berm has been constructed around the yard; and until the 1972-73 season, sand-salt mixtures were stored uncovered on the pad. Pure salt is stored in a shed on the pad. Prior to the 1972-73 season, both Township and Regional Municipality representatives were advised of the cause and effect relationship between the storage facilities and the aquifer water quality. These representatives responded by discontinuing the storage of unprotected salt at these patrol yards.

3. GEOLOGY

Stittsville is located approximately 12 miles south-west of Ottawa in the Township of Goulbourn. The study area lies on the flank of an old beach deposit formed by wave action during the time of the post glacial Champlain Sea. Local topography is sloping with up to a 1 in 25 gradient toward the east. The beach deposit consists of up to 50 feet of sand and gravel with occasional clay lenses. The lower ground to the north-east of the beach deposit consists mainly of sandy till deposits 30 to 40 feet in thickness. In some places adjacent to the beach deposit, the till is absent and sand and gravel overlies the bedrock. The bedrock underlying the village and nearby surrounding area consists of limestone of the Ottawa formation.

4. HYDROGEOLOGY

The local surficial sand and gravels are saturated and serve as a minor source of local ground water supply. This partially confined aquifer, because of the well drained nature of the overburden material, is highly susceptible to pollution from contaminants lost at ground surface.

In unconfined or partially confined aquifers, the configuration of the potentiometric surface generally conforms to topography. Ground water moves down-gradient under the influence of gravity from areas of high elevation toward areas of low elevation. Thus, ground water in this local overburden aquifer would be expected to move toward the east.

The major aquifer in the area, however, is not contained within the overburden, but is within the underlying fractured limestone bedrock of the Ottawa formation. The majority of the wells in the village and the surrounding area are

drilled into this limestone aquifer. Water-well records indicate that these wells extend from 2 feet to 140 feet into the bedrock but that the average depth of rock penetration is about 60 feet. The drilled wells are reported to produce sufficient quantities of water for domestic requirements; however, sulphurous water is encountered in some of the rock wells.

In bedrock aquifers, ground water tends to move primarily through fractures under the influence of gravity from topographically high areas toward topographically low areas. Thus water flow in the bedrock aquifer would be expected to be in an eastwardly direction from the salt storage facilities toward the affected wells.

5. WATER QUALITY

A. General

Upon receiving Mr. Labarre's request for an investigation of well water quality problems at Stittsville, a well-water sampling program was begun in the study area by representatives of the Water Quantity Management Branch. The collected samples were analyzed for pH, calcium, magnesium, sodium, potassium, MBAS as LAS, hydrogen, sulphide, sulphate, iron (soluble and total), nitrate, alkalinity, hardness and specific conductance. The analytic results of this sampling program are shown in Table 1.

As previously stated, water quality in the individual wells was reported to be fresh at the time of drilling. The Royal Bank well, drilled in 1968, may be used as a representative well for background quality. The water is free of chloride and nitrate contamination, but is relatively hard as would be expected with water from a limestone bedrock aquifer. Sobanski¹ commented that the potential for good quality water being obtained from the Ottawa formation in Stittsville is good to fair. The only apparent problem could be the presence of naturally occurring sulphurous water. In sampling three bedrock wells in Stittsville for analyses purposes, Sobanski found the water to be fresh and hard.

This report deals only with the quality of bedrock wells in the immediate study area. From an examination of the data presented in Table 1, it

is evident that well waters downgradient from the patrol yards contain anomalous concentrations of chloride, sodium, calcium, hardness and total dissolved solids as determined by the specific conductance data. The wells in the community also contain elevated concentrations of nitrate which appear to be somewhat unrelated to the presence of the above list of constituents and will be dealt with separately.

There are several potential sources of contaminants which must be considered when dealing with aquifer contamination as experienced at Stittsville. These include: natural sources of contaminants within the aquifer, septic tank effluents, discharge of industrial wastes with high contaminant concentrations, road salting and leachate from salt storage piles. The following discussion will attempt to deal with the nature and source(s) of the contaminants.

B. Well Water Contaminants

I. Chloride

(1) Occurrence and Chemistry of Chloride in Water

Chlorides are widely distributed in natural waters. They are found in sedimentary rocks deposited in marine environments. During deposition, the rock becomes impregnated with soluble salts and chloride is present as a part of sodium chloride crystals or in solution in interstitial water as the chloride ion. Fine grained marine shales that characteristically have small permeabilities, retain chlorides for very long periods of time, while outcropping, fractured and porous carbonate rocks, through which ground water percolates and leaches salt from the interconnected pore space, would not be expected to retain large amounts of chlorides.

The circulation of chloride ions in the hydrologic cycle is largely through physical processes. Chloride ions in natural waters do not readily enter into oxidation or reduction reactions, do not form important ion complexes, do not form insoluble or slightly soluble salts, are not significantly adsorbed on mineral surfaces, and do not enter into biochemical reactions. Because of these factors, chloride ions move with the water through most soils with less retardation or loss than any other chemical. However, because the ion is physically large, its movement through compacted clays and shales may be retarded.

Chloride ions are present in all natural waters, but generally the concentrations are small. Rainwater has an average concentration of only a few tenths of a ppm. Surface streams usually have chloride concentrations of a few tens of ppms.

Chlorides in drinking water are generally not harmful² to human beings unless large concentrations are reached. However relatively low chloride concentrations may be injurious to some people suffering from diseases of the heart or the kidneys. Restrictions on chloride concentrations in drinking water are generally based on palatability requirements rather than on health factors.

Lockhart et.al.³ reported the taste thresholds of NaCl, KCl and CaCl₂ to be 345, 650 and 347 ppm, corresponding to chloride concentrations of 210, 310 and 222 ppm, respectively. For average individuals, the taste threshold is about 400 ppm. Water containing more than 500 ppm may be unpalatable and cause appetite disturbances. Although an excess of chloride induces thirst or can act as a diuretic, water containing up to 1400 ppm has been used by some communities for many years without appreciable harm. According to McKee et. al.² in general, it is the cation (calcium, magnesium, sodium, or potassium) associated with the chloride that produces a harmful effect.

Chloride limits, both those in use as standards and those recommended for use as possible standards, vary over a wide range. The USPHS Drinking Water Standards of 1962 recommended that chlorides do not exceed 250 ppm. In other agencies or other countries², the criteria have been given at values ranging from 5 ppm, which seems unrealistic to the writer, to 600 ppm. The WHO International Standards of 1958 set a permissible limit of 200 ppm and an excessive limit of 600 ppm. The maximum recommended limit for chlorides in municipal water supplies in Ontario is 250 ppm, Ministry of the Environment, "Guidelines and Criteria for Water Quality Management in Ontario, 1973".

In addition to the palatability and the possible hazard to health, chlorides are strong contributors to the rate of corrosion of metals.

- (2) Regional Chloride Concentrations in Ground Water from the Ottawa Formation in the Stittsville area.

Water quality data compiled by the Ministry of the Environment¹ indicates that naturally occurring concentrations of chloride are low in Ottawa Formation aquifers in the Stittsville area. These data are summarized as follows:

<u>Report Area</u>	<u>Chloride Concentration (ppm)</u>
Sarsfield	23
Navan	4
Twp. of Gloucester	39
Stittsville	23
Stittsville	56
Stittsville	111
Stittsville	10
Overall Average	38

These data represent average values of chloride concentrations found in representative wells throughout the region.

- (3) Chloride Concentrations in the Study Area

The average chloride concentration in the waters from wells beyond the contaminated area during the study period was 51.4 ppm. This average represents 39 samples collected from the Royal Bank, Lackey, Carlstan Manufacturing and Gauvan wells during the study period. This contrasts with an average concentration of 1438 and 1265 ppm of chloride in the Summer's and Miller's well water, respectively, located on figure 2. The data are recorded in Table 1 with average values for all wells sampled during the study.

In figure 3, isochlors have been drawn which join points of equal chloride concentration for averaged samples collected through the study period. Examination of the figure shows a pattern which suggests that the focal point of the large chloride concentrations is in the vicinity of the patrol yards upgradient from the affected wells.

II. Sodium

(1) Occurrence and Chemistry of Sodium in Water

The occurrence of sodium is similar to that described for chloride. Sodium may be present in sedimentary rocks as crystals of readily soluble sodium salts or in ionic form in aqueous solutions. In these forms, sodium may be flushed from permeable rocks by ground water flow.

Sodium ions, unlike chloride ions, may be removed from solution by adsorption on minerals with high cation exchange capacities, such as clays. Such reactions usually result in the release of calcium which consequently increases the hardness of the water. Because sodium can be adsorbed, it is not as good an indicator for tracing ground-water movement as chloride.

All natural waters contain measureable amounts of sodium. Natural concentrations range from about 0.2 ppm in rain and snow, to more than 100,000 ppm in the brines from very deep bedrock formations.

Sodium in drinking water may be harmful to persons suffering from cardiac, renal and circulatory diseases^{4,5}, and as much as 200 mg. of sodium from drinking water of good quality may contain up to 115 ppm sodium, Hibbard⁸ recommends a limit of 10 ppm as desirable.

The U.S. Public Health Service drinking water standards in current use date from 1962 and do not state a sodium concentration criteria to be maintained in drinking water supplies. There is no mention of recommended limits for sodium in municipal water supplies in Ontario in the "Ministry of the Environment, Guidelines and Criteria for Water Quality Management in Ontario, 1973".

(2) Regional Sodium Concentrations in Ground Water from the Ottawa Formation in the Stittsville Area.

Water quality data compiled by the Ministry of the Environment¹ indicates that naturally occurring concentrations of sodium are low in Ottawa Formation aquifers in the Stittsville area. These data are summarized as follows:

<u>Report Area</u>	<u>Sodium Concentration (ppm)</u>
Scarsfield	35
Navan	34
Township of Gloucester	13
Stittsville	22
Stittsville	27
Overall Average	26

These data represent average values of chloride concentrations found in representative wells throughout the region.

(3) Sodium Concentrations in the Study Area

The average sodium concentration of the waters from wells beyond the contaminated area during the study period was 25.3 ppm. This average represents 38 samples collected from the Royal Bank, Lackey, Carlstan Manufacturing, and Gauvan wells during the study period. This contrasts with an average concentration of 931 and 652 ppm of sodium in the Summer's and Miller's well water respectively, located in Figure 2. The data are recorded in Table 1 with average values for all wells sampled during the study.

In Figure 4, lines have been drawn which join points of equal sodium concentration for averaged samples collected through the study period. Examination of the Figure shows a pattern which suggests that the focal point of the large sodium concentrations is in the vicinity of the patrol yards upgradient from the affected wells.

III. Calcium

(1) Occurrence and Chemistry of Calcium in Water

Calcium is the principal cation in most natural fresh water. The element is very widely distributed in the common minerals of rocks and soil. The most common forms of calcium in sedimentary rocks are the carbonates. The two crystalline forms, calcite and aragonite, both have the formula CaCO_3 , and the mineral dolomite can be represented as $\text{CaMg}(\text{CO}_3)_2$. Limestone consists mostly of calcite with admixtures of magnesium and other impurities.

Equilibria involving carbonates are the major factor in limiting the solubility of calcium in most natural water. Weyl⁸ has concluded that saturation with respect to calcite should prevail for all water in limestone below the water table. But Back et.al.⁹ observed both supersaturation and under-saturation in water from wells in limestone bedrock aquifers and suggested that solution of limestone might continue for hundreds of feet below the water table. To fully examine natural water systems with reference to carbonate equilibria, pH measurements must be accurately made immediately when the source is sampled. Then by referring to a figure such as provided by Hem¹⁰, the equilibrium pH in relation to calcium and bicarbonate activities in solutions in contact with calcite can be obtained. By such a determination the degree of saturation with respect to calcite may be obtained.

As has been discussed, calcium ions may be released to solution by the process of ion exchange for sodium ions. If a solution with a high sodium concentration comes in contact with minerals with a high cation exchange capacity that has exchangeable calcium then in an approximate 2:1 ratio, sodium will exchange with calcium to maintain charge equilibrium. This will be discussed in more detail under the section, Ion Exchange Reactions. Because calcium enters into these reversible reactions with sodium, neither sodium nor calcium are as good an indicator for tracing ground water movement as chloride.

The human body requires approximately 0.7 to 2.0 grams of calcium per day as a food element^{11,6}, an amount considerably in excess of the calcium concentration of normally consumed quantities of even very hard water. In fact, calcium deficiency is a common nutritional problem in North America. It is assumed that in the adult, the calcium requirement in the diet should equal the calcium excretion, which is about 10 mg. per kg. per day¹⁰. Some investigators believe that calcium in water can be used by the body as a supplement to the calcium in the diet¹²; however, the nutritional value of calcium in water has not been clearly established and is still questionable^{13,14}. Concentrations up of 1800 ppm of calcium in drinking water have been reported to be harmless¹⁵.

Controversy also exists in the literature over the physiological effects of excessive concentrations of calcium in drinking water. Excessive calcium has been implicated as a factor predisposing to the formation of concretions in the body such as kidney or bladder stones¹⁶. Morris et. al.^{17,18} report an inverse correlation between the calcium content of waters and cardiovascular disease, i.e. high calcium is associated with a low incidence of heart attacks. Similar work has been progressing in southern Ontario in which an inverse correlation has been found between the hardness of waters (remembering that the main hardness ion is calcium) and heart attacks, i.e. communities with hard water tend to have a significantly lower per capita incidence of heart disease than communities with soft water. However, Schroder and Duran¹⁹ failed to find a similar relationship in Japan. There is also evidence of adverse physiological effects from an insufficiency of calcium in water. Urovs disease, a severe type of rickets, occurs in regions where the concentration of calcium in drinking water is low^{20,21}.

While several effects of calcium in drinking water and physiological reactions have been suspected, no definite causal relationship has been proven as yet. So far as can be determined at the present time, calcium limits are desirable for domestic supplies not because of a hazard to health, but because calcium may be disadvantageous for other household uses, such as washing, bathing and laundering, and because it tends to cause incrustations on cooking utensils, water heaters, etc.

Hibbard⁸ has recommended the following limiting concentrations of calcium in waters for domestic use:

Drinking and cooking	30 ppm
Washing	10 ppm
Laundry	0 ppm

The USPHS Drinking Water Standards of 1962 and the WHO European Standards of 1961 do not contain any limits for calcium; but the WHO International Standards of 1958²² indicate that 75 ppm is a permissible limit and 200 ppm is an excessive limit in drinking water. There is no mention of recommended limits for calcium in

municipal water supplies in Ontario in the "Ministry of the Environment, Guidelines and Criteria for Water Quality Management in Ontario, 1973".

(2) Regional Calcium Concentrations in Ground Water from the Ottawa Formation in the Stittsville Area

Water quality data including analyses for calcium have not been compiled by the Ministry of the Environment in previous regional studies. Thus comments on naturally occurring concentrations of calcium in Ottawa Formation aquifers in the Stittsville area are not possible.

(3) Calcium Concentrations in the Study Area

The average calcium concentration of the waters from wells beyond the contaminated area during the study period was 111.5 ppm. This average represents 30 samples collected from the Royal Bank, Lackey, Carlstan Manufacturing, and Gauvan wells during the study period. This contrasts with an average concentration of 258 and 265 ppm of calcium in the Summer's and Miller's well waters respectively, located in Figure 2. The data are recorded in Table 1 with average values for all wells sampled during the study.

IV Hardness

(1) Occurrence and Chemistry of Hardness in Water

The term "hardness" is applied to the soap-neutralizing power of a water. Any substance that will form an insoluble curd with soap causes hardness. The most common ions that form the curd in natural water supplies and thus the ion to which hardness is principally attributable are the calcium and magnesium ions. Hardness in water thus may be caused by the natural accumulation of salts from contact with soil and geological formations. Because the hardness of water is directly related to the presence of calcium in the water, the reader is referred to the section, "Occurrence and Chemistry of Calcium in Water".

Physiologically, hard waters have had no demonstrable harmful effects on the health of consumers. Again the reader is referred to the section, "Occurrence and Chemistry of Calcium in Water". The major detrimental effect of hardness is

economic. Aultman has shown²³ that the annual cost of cleansing agents for a family of five doubles as the hardness increases from zero to 375 ppm.

The literature contains numerous statements relating to the desirable limits for hardness in municipal water supplies. According to Taylor¹¹, in a few hard-water areas, a commonly prescribed limiting hardness is 140 ppm while a hardness above 500 ppm is considered unsuitable for general domestic purposes.

The USPHS Drinking Water Standards of 1962, the WHO European Standards of 1961 and the WHO International Standards of 1958 do not contain any limits for hardness. The "Ministry of the Environment, Guidelines and Criteria for Water Quality Management in Ontario, 1973" contains the following statement under the heading "Permissible Criteria". "Acceptable levels will vary with local hydrogeologic conditions and consumer acceptance".

(2) Regional Hardness Concentrations in Ground Water from the Ottawa Formation in the Stittsville Area

Water quality data compiled by the Ministry of the Environment¹ indicates that water from Ottawa Formation aquifers in the Stittsville area is very hard.

These data are summarized as follows:

<u>Report Area</u>	<u>Hardness (as ppm CaCO₃)</u>
Sarsfield	286
Navan	190
Township of Gloucester	272
Stittsville	244
Stittsville	280
Stittsville	411
Stittsville	252
Overall Average	305

These data represent average values of hardness expressed as ppm CaCO₃ found in representative wells throughout the region.

(3) Hardness in the Study Area

The average hardness of the water from wells beyond the contaminated area during the study period was 400 ppm CaCO_3 . This average represents 30 samples collected from the Royal Bank, Lackey, Carlstan Manufacturing and Gauvan wells during the study period. This contrasts with an average hardness of 731 and 740 ppm CaCO_3 in the Summer's and Miller's well waters respectively, located in Figure 2. The data are recorded in Table 1 with average values for all wells sampled during the study.

V. Nitrate

(1) Occurrence and Chemistry of Nitrate in Water

Nitrates are the end product of the aerobic stabilization of organic nitrogen, and as such they occur in polluted waters that have undergone aerobic biological processes. Nitrates also occur in percolating ground waters as a result of excessive application of fertilizer or leachings from septic tanks systems.

The USPHS Drinking Water Standards recommends a limit of 10 ppm nitrate nitrogen as N, with which the Guidelines and Criteria for Water Quality Management in Ontario by the Ministry of the Environment concurs. These limits were established because of the relationship between high nitrates in water and infant methemoglobinemia.

Infant methemoglobinemia, a disease characterized by certain specific blood changes and cyanosis, may be caused by high nitrate concentrations in the water used for preparing feeding formulae. Since the disease often does not occur even where the water is very high in nitrate content, however, it seems likely that not all infants are susceptible to nitrate poisoning, but that some are predisposed to it by physiological conditions. Many well waters containing over 500 ppm nitrate nitrogen have never been linked with reported cases².

Excess nitrates cause irritation of the mucous linings of the gastrointestinal tract and bladder, with symptoms of diarrhea and diuresis. Drinking one liter of water containing 500 ppm nitrate can cause such symptoms²⁴.

(2) Regional Nitrate Concentrations in Ground Water from the Ottawa Formation
in the Stittsville Area

Water quality data compiled by the Ministry of the Environment¹ indicates that naturally occurring concentrations of nitrate are low in Ottawa Formation aquifers in the Stittsville area. These data are summarized as follows:

<u>Report Area</u>	<u>Nitrate Concentration (as ppm N)</u>
Sarsfield	0.03
Navan	0.01
Township of Gloucester	0.20
Stittsville	1.3
Stittsville	8.2
Stittsville	1.97
Stittsville	tr.
Overall Average	1.67

These data represent average values of nitrate concentrations found in representative wells throughout the region.

(3) Nitrate Concentrations in the Study Area

The average nitrate concentration in the waters from wells beyond the contaminated area during the study period was 0.55 ppm. This average represents 30 samples collected from the Royal Bank, Lackey, Carlstan Manufacturing and Gauvan wells during the study period. This contrasts with an average concentration of 5.8 and 5.2 ppm of ^{NO₃}chloride in the Summer's and Miller's well waters respectively, located on Figure 2. The data are recorded in Table 1, with average values for all wells sampled during the study.

In Figure 5, lines have been drawn which join points of equal nitrate concentration for averaged samples collected through the study period. Examination of the figure shows basically that the NO₃-N concentration increases downgradient with distance from the patrol yard.

C. SOURCES OF CONTAMINANTS

As outlined there are several potential sources of contaminants in the study area. To separate the sources an examination of the chemical relationships between waters from the various sources has been undertaken. This has involved the presentation of the chemical data in graphical form and the study of ion exchange relationships in the aquifer waters.

I. Piper and Schoeller Chemical Plots

The Piper plot is a trilinear diagram which illustrates the percentages of major anions and cations in the water samples. Anions and cations are shown separately in two triangular fields and are combined in a diamond-shaped field. Trilinear diagrams are useful in pointing up differences or similarities between waters and can also show the effects of mixing between waters. Mixtures of two different waters will plot as points on a straight line between end points which represent the two water types.

A Piper plot, Figure 6, was prepared from the analytic results for waters collected from wells in the study area on September 26, 1972. The data for the plot are presented in Table 2. Straight lines can be drawn from the Summers to the Walton well water quality as plotted on the diagram. Extending these straight lines to the vertices of the triangles in the diagram indicates that the contaminant is a sodium chloride water. Thus, water containing high concentrations of sodium chloride infiltrates to the aquifer, mixes with the normal ground water and produces the contaminated water found in the Summer's well.

The Schoeller plot or nomograph, depicts a group of analyses on equidistant verticals. By joining points on all vertical lines an analysis is shown as a characteristic broken line which represents the chemical composition of the water. Waters of similar composition plot as near-parallel lines. This graph is especially useful for comparing waters of low concentration and waters which do not differ greatly in concentration.

A Schoeller plot, Figure 7, was prepared from the analytic results for waters collected from wells in the study area on September 26, 1972. The

data for the plot are presented in Table 2. As can be seen from the plot the contaminated wells show their similar composition by the near parallel lines representing the chemical composition of the waters. Mixing of background quality water containing low sodium chloride concentrations with the sodium chloride water is evidenced by the systematically decreasing slopes of the lines representing the water quality at the various sample points.

II. Ion Exchange Reactions

The following calculations indicate that increased chloride concentrations in well waters in the study area are associated with both increased sodium and hardness ions. The increase in hardness ions corresponds with the concept of ion exchange in soil reactions. These reactions involve positive sodium cations originating with the chloride sources being absorbed by soil particles resulting in the release of calcium, magnesium and iron ions. For the calculations, increases in ion concentration from one sampling period to the next were considered on an individual well basis. An example of the calculation follows:

Blaney Well:	Sample Date	Concentration (ppm)		
		<u>Na</u>	<u>Cl</u>	<u>Hardness</u>
	26/9/72	68	124	412
	22/11/72	253	631	732

Chloride increase: $631-124=507$

Sodium equivalent of chloride difference: $(507/35.5) \times 23=328.5$

Actual sodium analysis: 253

Sodium increase: $253-68=185$.

Therefore, $328.5-185=143.5$ ppm Na may have been exchanged for hardness ions in the soil.

Equivalent hardness (Ca, Mg, Fe) potentially released by sodium absorbed at $2\text{Na}=\text{CaCO}_3$

$143.5 \times 100/(23 \times 2) = 312$ ppm CaCO_3 = increase in hardness expected.

Therefore, $412 + 312 = 724$ ppm is the expected hardness.

Actual hardness = 732

Error = 1.1%

Similarly for other wells in the study area, it can be demonstrated, within analytical error, that the increase in hardness is due to ion exchange between the contaminant sodium ions and calcium, magnesium and iron ions which are normally absorbed on soil materials.

III. Natural Occurrence of Contaminants

As has been pointed out under the subsections I, II, III, IV, and V, of Section 5B, contaminants are widely distributed in natural waters, but generally the concentrations are small. Water-quality data compiled by the Water Quantity Management Branch indicates that naturally occurring concentrations of chloride, sodium, calcium, hardness and nitrate in the Stittsville area are low.

IV. Septic Tank Effluents

Septic tank effluents may be suspected as a source of sodium chloride, particularly if local use of water softeners is prevalent. However, septic tank effluents seldom contain more than 80 ppm Cl and therefore could not produce chloride concentrations of up to 2300 ppm as observed in local wells. It has been the experience of the Ministry that aquifers which have been polluted with septic tank effluents rarely have increases of chloride concentrations that exceed 10 ppm.

Septic tank effluents do contain large concentrations of nitrate nitrogen. Analysis of samples collected during this study indicate that approximately 25 per cent of the 44 sampled wells have yielded water with nitrate (N) concentration at or in excess of the Ministry's maximum criteria of 10 ppm. Coliform counts are high in several wells. These nitrate concentrations and bacterial counts indicate that the septic systems are having an adverse effect on the ground water quality. An additional 30% of the well waters contained nitrate concentrations between 5 and 10 ppm.

Based on current practices in spacing private septic tank and well

systems, the lot sizes in the area appear to be adequate. However, it is evident that high nitrate levels prevail in the community.

The study area occupies about 0.06 square miles. Ground water in the area would be recharged by precipitation at an average rate of about 18,000 gpd assuming an average recharge rate for the sand and gravel area of 300,000 gpd/sq. mile. The septic tank systems in the area would contribute approximately 4,000 gpd to the ground water with an average nitrate concentration of 40 ppm. Mixing with the natural recharge would dilute the septic effluent about 4 times and result in an expected nitrate concentration in the ground water of about 10 ppm. This agrees reasonably well with the sampling results.

If there were dilution from upgradient ground water sources, the nitrate levels would be lower. However, in the study area, there is little dilution from upgradient flow because a partial ground water divide exists just to the north west of the study area. Variations in nitrate concentrations occur because of dilution variations due to rainfall events. It is also evident that a nitrate buildup occurs in the ground waters as the distance downgradient from the ground water divide increases and the recharge dilution factor is reduced.

V. Industrial Sources

There are no known industrial sources of the contaminants in the study area.

VI. Salt Storage and Road Salting

The source of the salt contaminant must be located ~~down~~^{up}gradient from the unaffected wells in the area. These wells include the Gauvan, Carlstan, Lackey, Royal Bank, Village of Stittsville and Carleton County wells, the locations of which are shown in Figure 1. The only such source of salt is that lost in the vicinity of the patrol yards upgradient from the affected wells. If road salting of Main Street South, County Road #5, through Stittsville was the main source of the salt contaminant, then wells such as those of the Royal Bank, the Village of Stittsville and Carleton County in a downgradient position

relative to the road would also be affected. These wells have virtually background concentrations of the salt contaminant.

6. DISCUSSION AND CONCLUSIONS

Many residents of the Village of Stittsville have experienced a deterioration of their well water quality. Their complaints to the regional office of this Ministry resulted in an extended well water sampling program. The analytical results of this program indicate that water with a high salt concentration contaminates the aquifer on a continuous basis. There is also evidence that septic wastes are entering the aquifer resulting in nitrate and bacterial contamination of many of the local wells.

Uncovered salt has been stored upgradient from the affected wells for the period of time between 1960 and 1973. Downgradient aquifer use intensified in 1965 with the development of the community shown in Figure 2. Originally the water from this aquifer was reported to be fresh, but has since become undrinkable with chloride concentrations reaching 2252 ppm chloride.

The study area lies on a sand and gravel beach deposit that is highly permeable. Underlying this overburden material, at depths up to 50 feet, is fractured limestone bedrock of the Ottawa Formation. The aquifers contained within these materials normally yield good quality water. These aquifers are particularly vulnerable to the infiltration of pollutants because of the permeable nature of the overburden materials.

Ground water movement in both the overburden and bedrock aquifers is in an eastwardly direction in the study area with a local ground water divide being found in the vicinity of the north-south County road #5. The aquifer yielding water to the affected wells in the study area is located at an average penetration of 60 feet into the bedrock.

The affected wells contain anomalous concentrations of chloride, sodium, calcium, hardness and dissolved solids. Chloride ions are present in all natural waters and because of its physio-chemical characteristics, the ion moves with water through most soils with less retardation or loss than any other chemical.

While the chloride concentrations in these waters are far beyond the taste thresholds for chloride salts, it is doubtful that the chloride ion itself is physiologically harmful at anything but extremely high concentrations. Limitations applied to the ion concentration by various regulatory agencies seem to be based primarily on taste threshold values. In general, it is assumed that it is the cations (calcium, magnesium, sodium or potassium) associated with the chloride that produces a harmful effect. Background chloride concentrations in the study area average 38 ppm, approximately 30 times lower than the concentration of chloride in the affected wells.

Sodium is also found in measureable amounts in all natural waters. It does however enter into ion exchange reactions as has been discussed in detail making it an unsuitable tracer ion. Sodium ions in drinking water may be harmful to persons suffering from cardiac, renal and circulatory diseases. While recommended limits vary from 10 to 115 ppm Na, it must be assumed that the water from the affected wells with Na concentrations in the 600 to 900 ppm range must be considered unfit for human consumption from a physiological point of view.

Calcium is the principal cation in most natural fresh water. The ion enters into reversible cation exchange reactions with sodium and thus is not a good indicator for tracing ground water movement. As to the physiological effects of excess calcium in drinking water, no definitive statement can be made. Calcium is an essential food element that may be deficient in the average North American diet. Concentrations of 1800 ppm Ca are reported to be harmless and it is reported that there is an inverse relationship between the calcium content of waters and cardiovascular disease. The main disadvantage of excess calcium in domestic water supplies is the adverse effect on washing and its tendency to form incrustations of calcium carbonate on cooking utensils and taps, water heaters, irons, etc. Calcium concentrations in the affected wells are approximately double background values and as has been shown are directly as a

result of ion exchange reactions between sodium and calcium ions.

Because of exchange reactions, it has been shown that the increased hardness of the waters in the study area is directly related to entrance of excess sodium ions into the aquifer. As a result of the increased hardness many of the affected residents have begun to use a water softener. In the softener, hardness ions are exchanged for sodium ions. Thus softened water contains increased sodium and chloride ions. The discharge of this water via the septic system into the aquifer results in further ion exchange reactions. These reactions exchange hardness ions for the excess sodium. Thus, in effect, it is possible for water softening activities in a community to result in the increased hardness of aquifer water, with the resultant increased use of sodium to reduce the increased hardness etc. In general the water in the study area is very hard. With the increase of hardness through the increase of sodium concentrations in the aquifer, the water has become excessively hard and by some standards, unsuitable for general domestic purposes. Efforts by local residents to soften their water has only increased the aquifer water hardness and increased their already extensive use of sodium chloride to soften their domestic supplies. Physiologically the hardness of the water is not of concern; however, its excess concentration has resulted in an economic hardship which has been borne by the residents as a direct result of the excessive loss of salt to the aquifer.

Anomalous concentrations of nitrate in the aquifer, in the absence of excessive fertilizer applications in the area must be related to the leaching of septic tank waste waters into the aquifer. Concern must be exhibited over the nitrate concentration in the aquifer because it exceeds recommended concentrations. Infant methemoglobinemia, irritation of the mucous linings of the gastrointestinal tract and bladder and symptoms of diarrhea and diuresis are all linked to the presence of excess nitrate in drinking water. The source of the nitrate problem has been shown to be from local septic tanks through the use of an estimate of the natural and septic recharge rate to the aquifer.

The problem is as a result of the lack of dilution from upgradient ground water sources. Because a partial ground water divide exists just to the north west of the study area, the ratio of natural recharge to septic waste is low. Thus nitrate levels are excessive.

Through the use of the Piper and Schoeller plots, it has been shown that the contaminant is a sodium chloride water. Sodium chloride water has infiltrated to the aquifer, mixed with the normal ground water and produced the contaminated waters found in the affected wells. It has also been demonstrated that increased calcium and hardness concentrations in the affected wells is as a result of ion exchange reactions between the ions in question and the introduced sodium ions.

There are no industrial sources of the salt contaminant, nor is road salting the contaminant source. Thus it must be concluded that the only logical source of excessive salt in the aquifer are losses from the storage facilities of the Regional Municipality of Ottawa-Carleton and the Township of Goulbourn. Uncovered salt stored or spilt at these facilities is subject to leaching and migration into the nearby aquifers. This process would have continued throughout the period of time that salt was exposed to leaching by rain or snow water.

7. ALTERNATE SOURCES OF SUPPLY

Several alternatives are available to restore potable supplies to affected residents. These include:

- 1) reverse osmosis equipment could be installed to treat drinking and cooking water supplies.

- 2) it may be possible to obtain an uncontaminated supply from the bedrock. However, there is no guarantee that such a supply exists. It would be imperative to case and grout off any contaminated zones to prevent the introduction of salty water into deeper aquifers through the well bore.

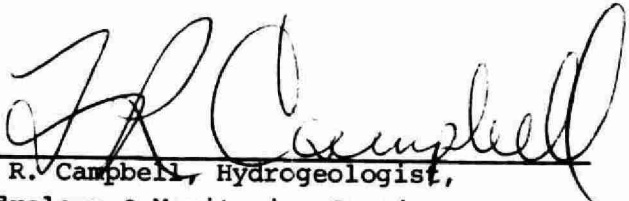
- 3) water could be hauled to the residences while waiting for natural dilution of the contaminant to reduce its concentration in the aquifer.

8. RECOMMENDATIONS

1) No further storage of unprotected salt be permitted at these patrol yards. Without the entrance of additional salt to the aquifer, natural dilution processes should restore the aquifer water back to its original quality.

2) The Ministry of Health in conjunction with the local health unit advise residences of the adviseability of drinking the local well water with consideration being given to the presence of bacteria, nitrate and dissolved ions at levels above recommended concentration limits.

REPORT BY:


F. R. Campbell, Hydrogeologist,
Hydrology & Monitoring Section,
Water Resources Branch.

1/5/74

FRC/af

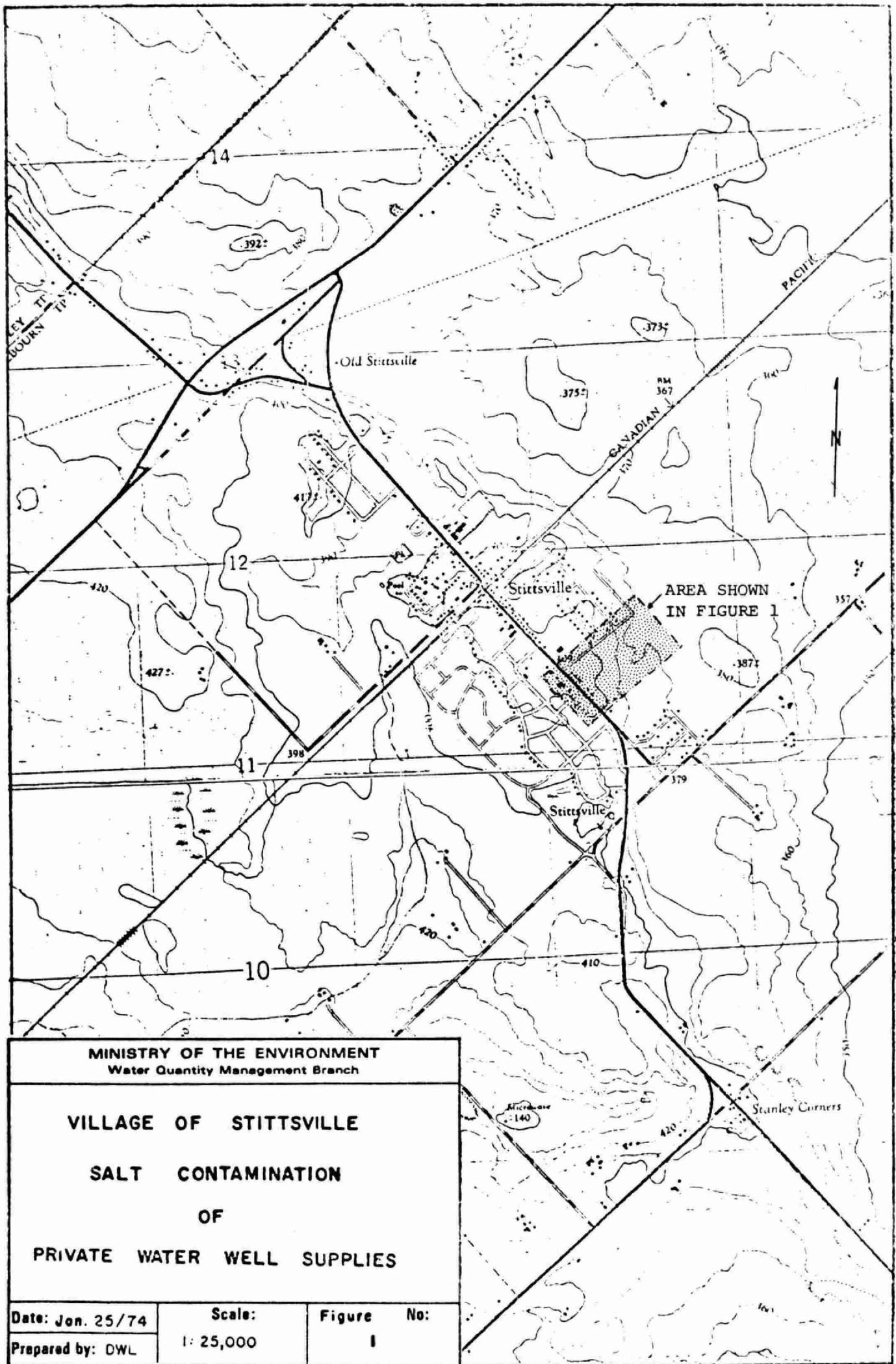
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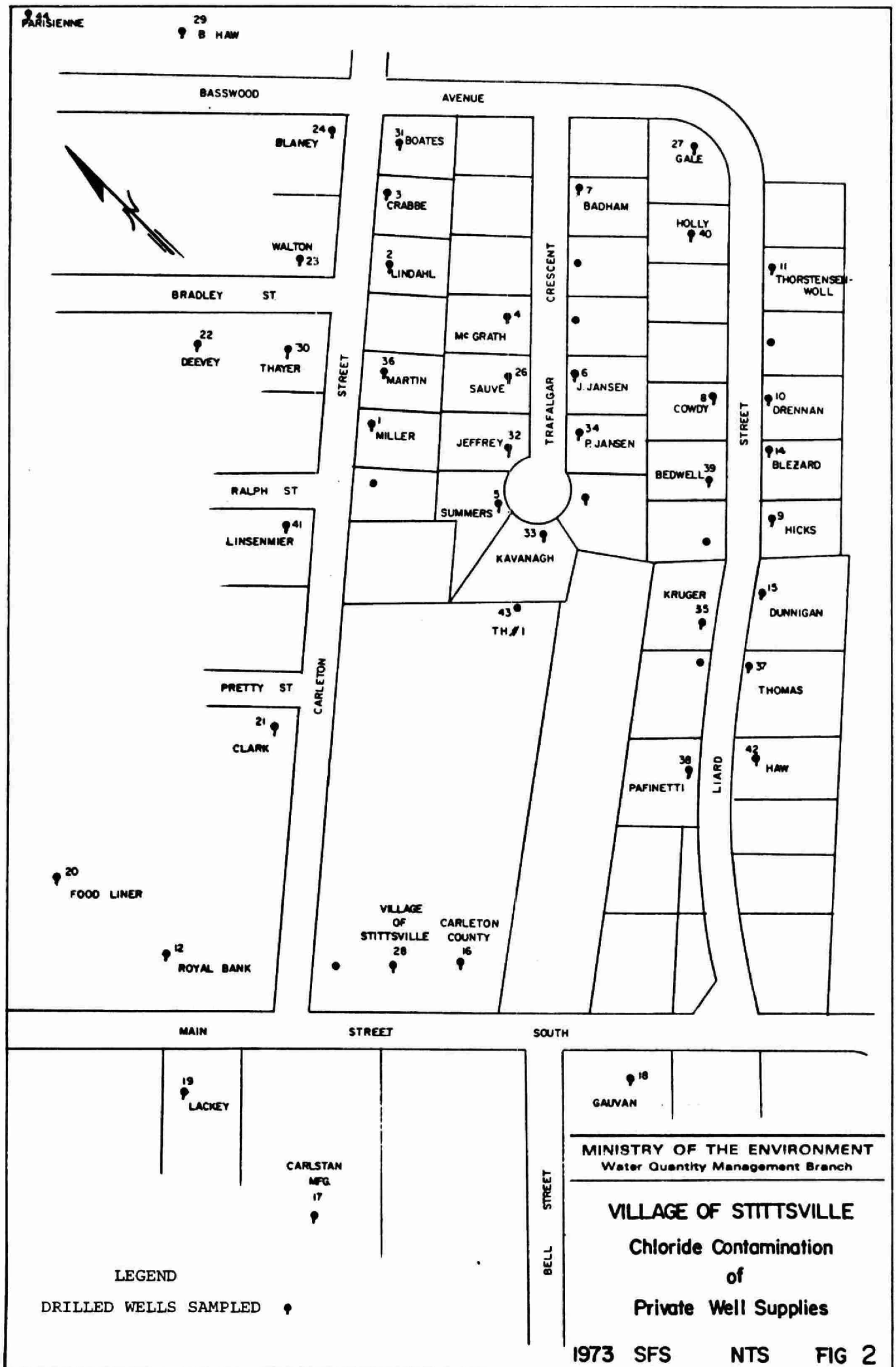
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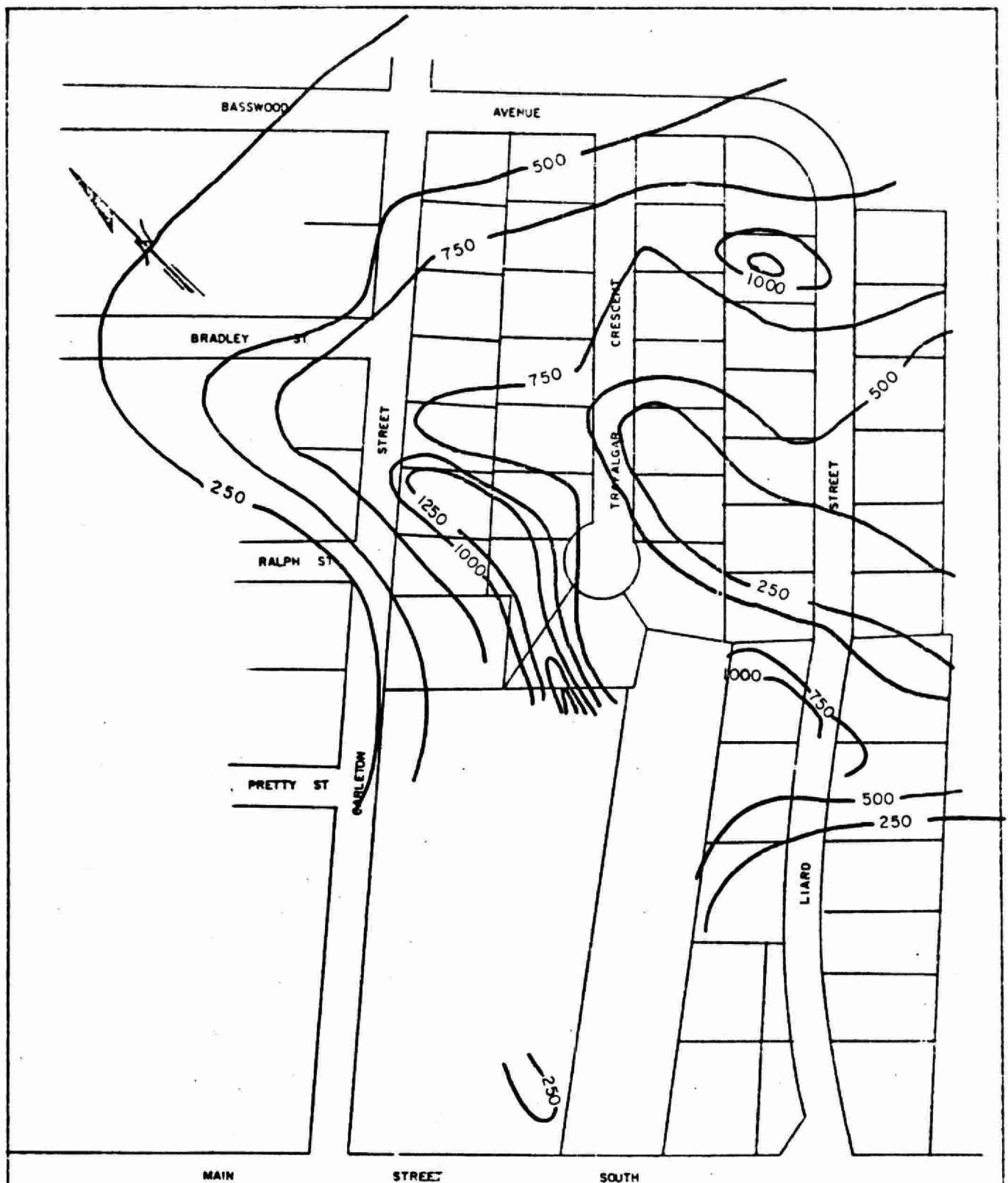
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TABLES AND FIGURES







MINISTRY OF THE ENVIRONMENT
Water Quantity Management Branch

VILLAGE OF STITTSVILLE

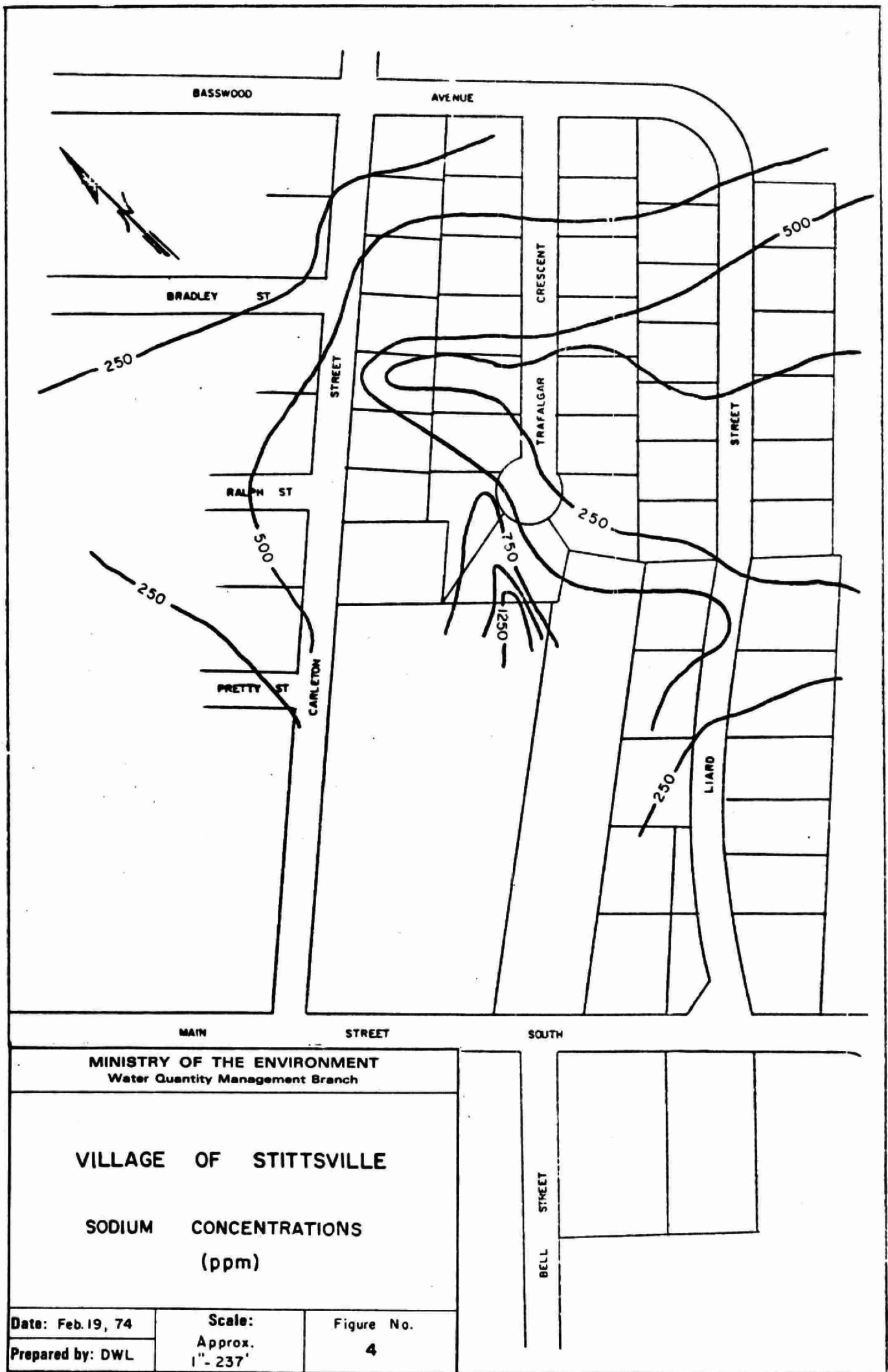
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(ppm)

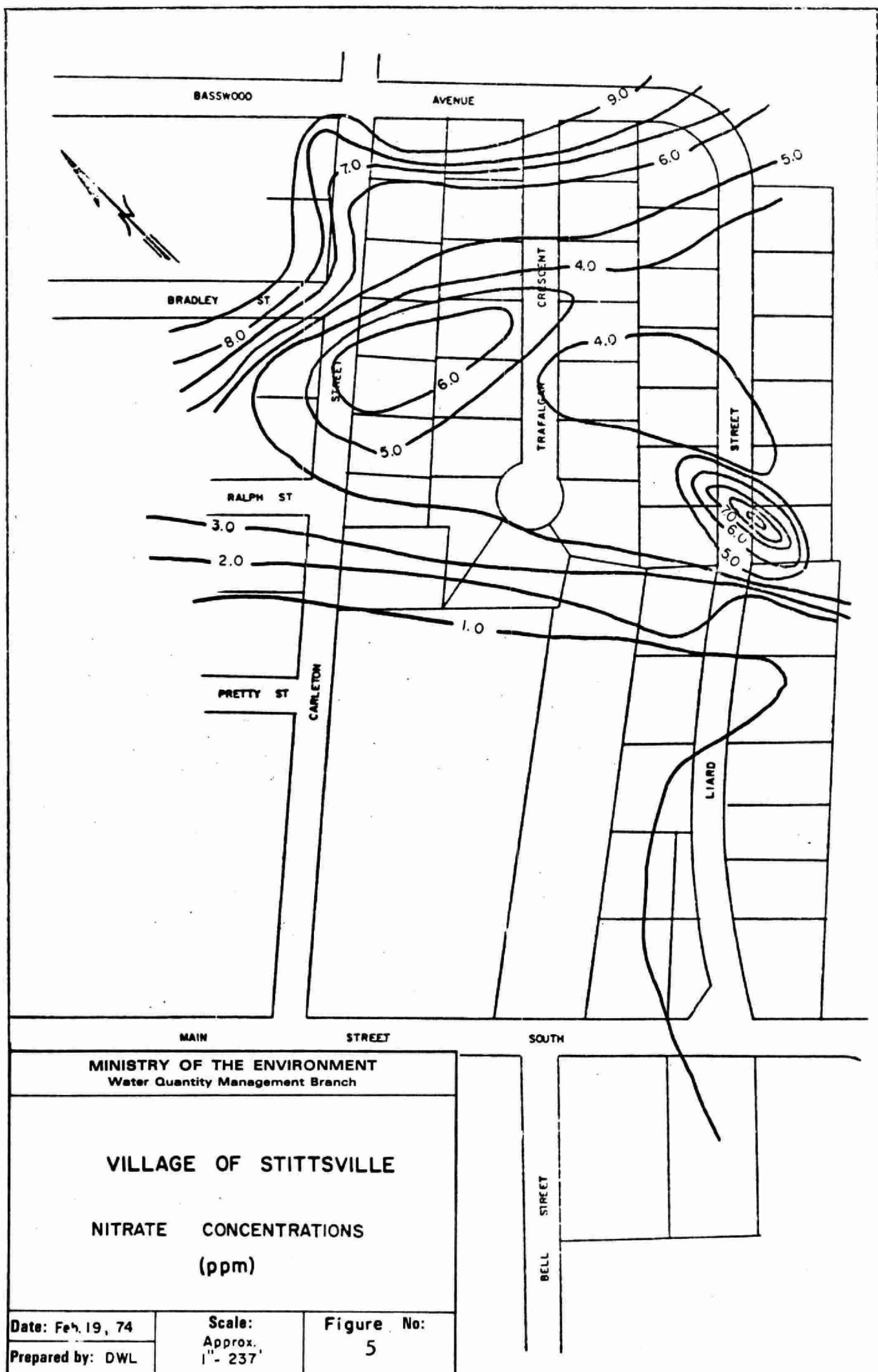
Date: Feb. 19, 74

Prepared by: DWL

Scale:
Approx.
1" = 237'

Figure No:
3





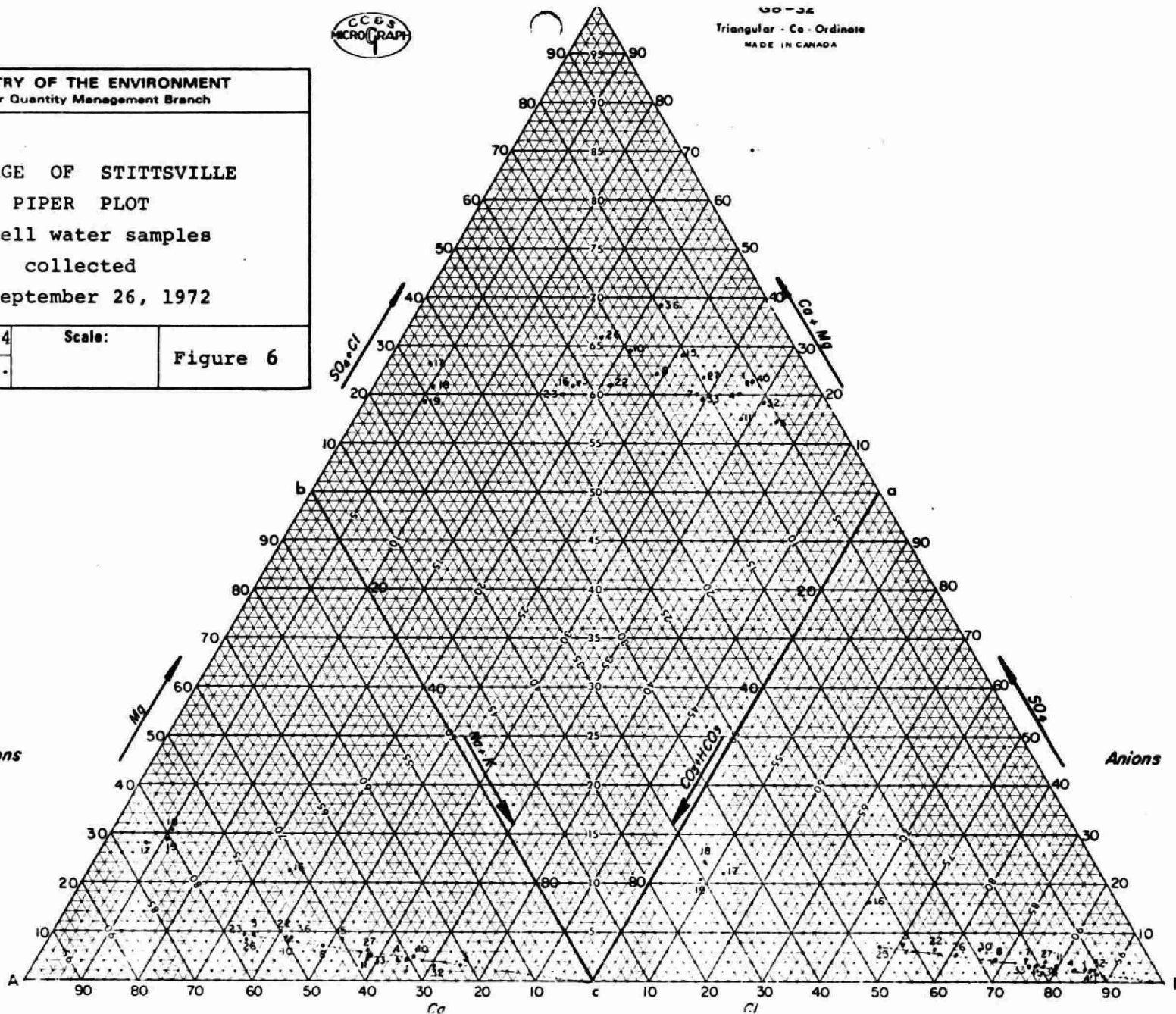


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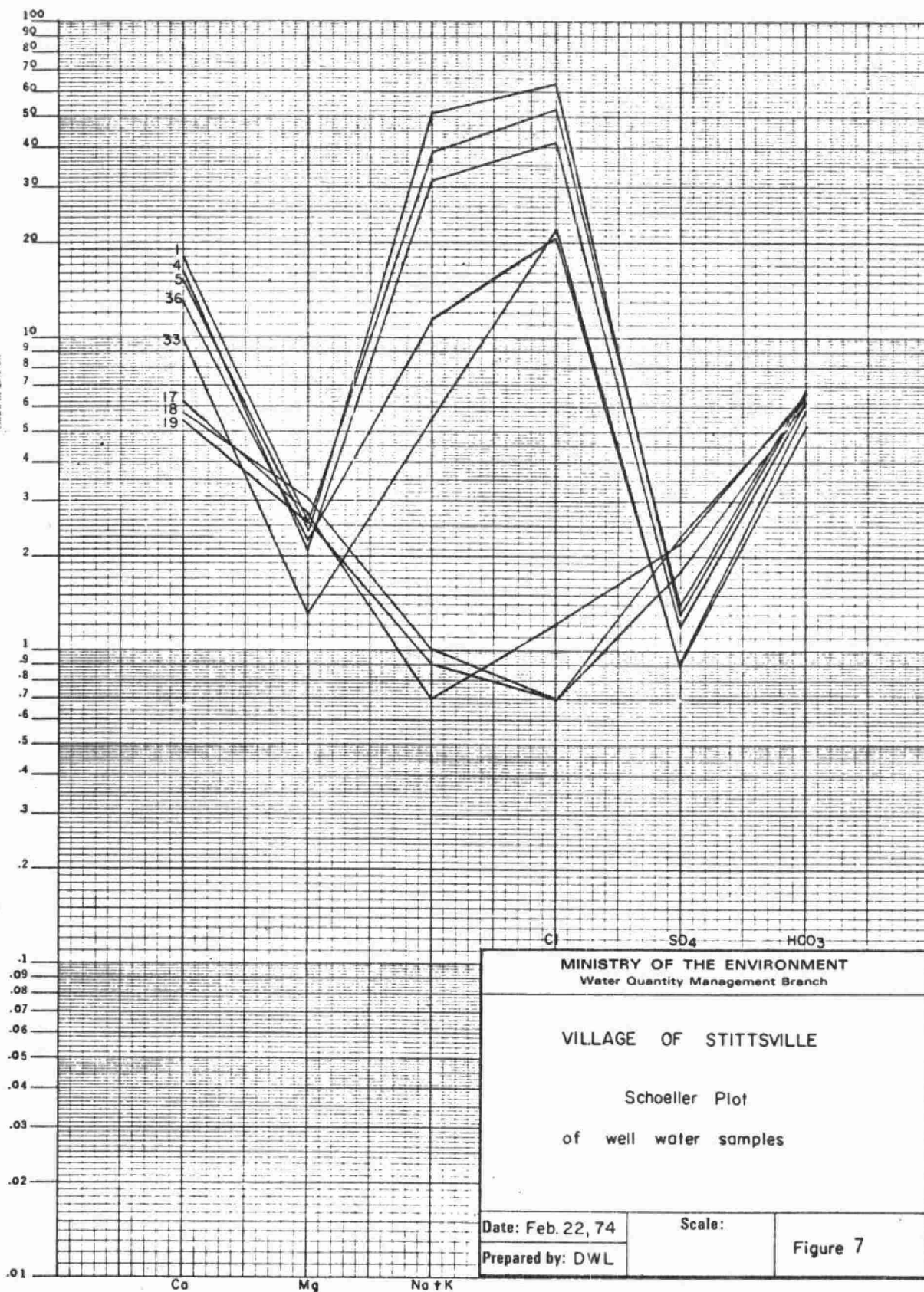
MINISTRY OF THE ENVIRONMENT Water Quantity Management Branch		
VILLAGE OF STITTSVILLE PIPER PLOT Of well water samples collected on September 26, 1972		
Date Feb. 22, 74	Scale:	Figure 6
Prepared by: D.L.		

Cations

Anions



GB-81
Semi-Logarithmic, 4 Cycles X 10 to the Inch
MADE IN CANADA



MINISTRY OF THE ENVIRONMENT

Table Summary of Water Well Records

Date

Prepared by

Well No	Location and Elevation	Owner	Driller	Well Type	Well Diameter (inches)	Depth (feet)	Static Level (feet)	Pumping Test (gpm) (hrs)	Pumping Level (feet)	Quality	Use	Remarks Log etc
	ELEV. LOG. NO. con lot		year									
1	VILLAGE OF STITTSVILLE 394 9353	2 J.D. MILLER	CAPITAL 63	9	5	73	17	10	17	F	D	SD - SAND GR - GRAVEL BLDR - BOULDERS LS - LIMESTONE 0-SD-30-GR,BLDR-760 38-LS-73 73
2	387	5 R. LINDAHL										
3	382 9388	6 CRABBE	CAPITAL 67	9	5	55	2	10	2	F	D	0-SD,GR-12-LS-55 #54
4	379 10687	11 McGRATH	CAPITAL 70	9	5	46	0	60	2	F	D	0-SD,GR,BLDR-15LS-46 #45
5	396 9994	14 M.G. SUMMERS	CAPITAL 69	9	5	49	15	10	17	F	D	0-SD-28-LS-49 #48
6	383 9372	18 J. JANSEN	C.H. SPARKS 67	9	4	30	8	5	10	F	D	0-STONES,GR-20-LS-30 #20-30
7	378 10869	21 BADHAM	CAPITAL 70	9	5	35	FLOW	10	-	F	D	0-S&CLAY, BLDR-7-LS-35 #35
8	384 10377	27 G.R. COWDY	CAPITAL 69	9	6	57	7	10	7	F	D	0-SD,BLDR,TILL-7-SD,CLAY,BLDR-27-LS-57 #57
9	387 10090	30 T.A. HICKS	CAPITAL 69	9	5	70	12	10	15	F	D	0-SD,GR-21-LS-70 #68
10	384 10674	32 DRENNAN	CAPITAL 70	9	5	50	5	10	9	F	D	0-SD,STONES-6-SILT-15-LS-50 #49
11	382 9699	34 THORSTENSEN-WOLL	CAPITAL 68	9	5	44	5	10	6	F	D	0-SD,GR,BLDR-11-LS-44 #42

MINISTRY OF THE ENVIRONMENT

Table Summary of Water Well Records

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Well No.	Location and Elevation			Owner	Driller	Well Type	Well Diameter (inches)	Depth (feet)	Static Level (feet)	Pumping Test (gpm) (hrs)	Pumping Level (feet)	Quality	Use	Remarks Log etc
	ELEV.	LOG NO.	con lot		year									
12	400	9379		ROYAL BANK	C.H. SPARKS 68	☐	4	83	30	5 $\frac{1}{2}$	35	F	D	0-GR-6-SD-29-LS-83 #60-83
14	385	10233		BLEZARD	CAPITAL 69	☐	5	56	10	5	38	F	D	0-SD, BLD-17-LS-56 #56
15	388	10086		DUNNIGAN	CAPITAL 69	☐	5	85	20	10	30	F	D	0-SD, GR, BLD-33-LS-85 #88
16	400	2732		CARLETON COUNTY	SPARKS 56	☐	4	125	20	3 $\frac{1}{2}$	25	F	D	0-GR-8-SD-35-LS-125 #125
17	400	2607		CARLSTAN MFG.	SPARKS 48	☐	5	115	30	-	-	F	COM.	0 GR 40 LS-115 #110
18	400	2622		GAUVAN	SPARKS 55	☐	4	70	16	4 $\frac{1}{2}$	19	F	D	0-SD, GR 27 LS 70 #55
19	400	2620		LACKEY	SPARKS 55	☐	4	65	18	4 $\frac{1}{2}$	21	F	D	0 SD 30 GR 33 LS 65 #50
20	404	2795		FOOD LINER	DUFRESNE 60	☐	6	75	15	20	75	F	COM.	0 SD, GR 29 LS 75 #70
21	400	9336		CLARK	CAPITAL 62	☐	5	117	25	10	28	F	D	0 SD, GR, BLD 10 SD 50 LS 117 #80-115
22	400	2755		DEEVY	M ^c LEAN 58	☐	5	75	12	5	12	F	D	0 SD, BLD 33 LS 75 #75
23	388	2763		WALTON	M ^c LEAN 59	☐	5	75	8	5	15	F	D	0 SD, BLD 27 LS 75 #75

MINISTRY OF THE ENVIRONMENT

Table Summary of Water Well Records

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Well No	Location and Elevation			Owner	Driller	Well Type	Well Diameter (inches)	Depth (feet)	Static Level (feet)	Pumping Test (gpm) (hrs)	Pumping Level (feet)	Quality	Use	Remarks, Log, etc
	ELEV.	LOG NO.	con lot											
24	382	9337		BLANEY	M ^C LEAN	61	6 1/4	65	4	10	15	F	D	0 SD 14 LS 65 *63
26	387	11188		A. SAUVE	CAPITAL	71	6	33	6	10	15	F	D	0 FILL 5 SD, 6A, BLDR 26 LS 33 *32
27	380	11457		REEVES	CAPITAL	71	6	33	-	-	30	F	D	0 CL 8 LS 33 *31
28	402	2769		VILLAGE OF STITTSVILLE	SPARKS	59	4	125	25	5 1/2	30	F	D	0 COARSE GA 10 SD 35 LS 125 *90-110
29	385	9328		B. HAW	MOLLOUGHPEY	61	4	61	20	6	30	F	D	0 SILT 10 BLDR, SILT 17 LS 61 *61
30	391	2756		THAYER	M ^C LEAN	59	5	75	14	5	14	F	D	0 SD, BLDR 31 LS 75 *75
31	379	9365		BOATES	CAPITAL	66	5	60	3	10	5	F	D	0 GR, BLDR 11 LS 60 *58
32	396	9696		JEFFREY	CAPITAL	68	5	63	13	10	13	F	D	0 SD, GR 36 LS 63 *61
33	396	10251		W. KAVANAGH	CAPITAL	69	5	55	13	10	13	F	D	0 SD, GR 32 LS 55 *53
34	385	10024		P. JANSEN	SPARKS	68	4	22	7 1/2	5 1/2	9	F	D	0 COARSE GA 22 *15-22
35	388	10280		KRUGER	CAPITAL	69	5	70	10	10	23	F	D	0 SD, STONES 36 LS 70 *68

MINISTRY OF THE ENVIRONMENT

Table Summary of Water Well Records

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Well No.	Location and Elevation			Owner	Driller	Well Type	Well Diameter (inches)	Depth (feet)	Static Level (feet)	Pumping Test (gpm)(hrs)	Pumping Level (feet)	Quality	Use	Remarks Log etc
	con	lat			year									
36	395	9357		MARTIN	CAPITAL 65	9	5	70	14	10	14	F	D	0 HARDPAN, BLDR 23 #68 LS 70
37	390	10419		THOMAS	CAPITAL 69	9	5	80	17	10	40	F	D	0 SD, GR, BLDR 37 #77 LS 80
38	390	10663		DAFINETTI	CAPITAL 70	9	5	100	10	8	45	F	D	0 GR, SD, BLDR 17 SD. STONES 31 HARDPAN, SD, BLDR 43 #98 LS 100
39	385	10454		BEDWELL	CAPITAL 69	9	5	88	18	7'	23	F	D	0 SD, GR 30 HARDPAN, #75 BOULDER 38 LS 88 87
40	385	11471		HOLLY	CAPITAL 71	9	6	35	FLOW	15'	10	F	D	0 TOPSOIL, MUCK 3 SD #35 CL 10 LS 35
41	400	2757		LINSENMEIR	MCLEAN 59	9	5	73	24	5'	24	F	D	0 SD, BLDR 32 LS 73 #73
42	400	11045		HAW	CAPITAL 70	9	5	120	10	24'	11	F	D	0 SD, STONES 29 GR, BLDR 39 LS 120 #118
43	397			TH #1	MOE 73	0	2	22	21	-	-	SALT	T.H.	HAND DRILLED #22 0 COARSE SD 12 FINE SAND 22
44	385	9376		PARISIENNE	SPARKS 67	9	4	67	10	5 1/2	15	F	D	0 SD 20 LS 67 #59, 67

MINISTRY OF THE ENVIRONMENT

Table 1 Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS or LAS	Nitrate (NO ₃)	
1	J.D. Miller	11-1-72								1360										5.0	
		10-4-72				1510				297					152	3.1					
		12-6-72				4950				1428					614	3.4					
		11-8-72				3930		674	290	1020	49	<0.1	246	14	524	3.1		0.10	<0.1	5.3	
		26-9-72	7.2			6100		1036	336	1822	65	<0.1	361	32	890	3.8	0.25	<0.10	<0.1	6.0	
		22-11-72				3580		668	300	1083	56	<0.1	234	20	600	2.7	0.25	<0.05	<0.1	5.2	
		12-2-73	7.4			4045		624	294	1100	55	0	219	18	608	3.2	0.20	0.10	<0.10	5.1	
		12-4-73	7.3			4350		636	331	1197	51	0	221	20	675	3.6	0.2	0.1	<0.1	5.9	
		16-5-73	7.1			5500		904	341	1590	62		309	32	830	3.8	<0.05			6.8	
		2-8-73	7.1			5300		740	349	1520	64		257	23	785	3.4	.10			3.1	
		31-10-73	7.2			5200		640	352	1500	54		221	21	844	3.7	.10			5.0	
		AVG.	7.2			4447		740	324	1265	57	<0.06	259	23	652	3.4	<0.16	<0.09	<0.1	5.3	

MINISTRY OF THE ENVIRONMENT

Table / Summary of Water Analyses

Prepared by

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MINISTRY OF THE ENVIRONMENT

Table / Summary of Water Analyses

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Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
3	R. CRABBE (Hay)	11-1-72								1020										6.2	
		10-4-72				2210				567					353	3.1					
		12-6-72				1550				256					113	2.6					
		11-8-72				4470		870	299	1250	62	<0.1	336	7	588	4.1		0.10	<0.1	6.9	
		26-9-72	7.5			1650		480	332	277	65	<0.1	179	20	126	2.5	<0.05	<0.05	<0.1	11	
		22-4-72				3650		28	296	958	55	<0.1	9	1	805	1.4	<0.05	<0.05	0.1	5.6	
		12-2-73	7.4			3924		568	302	1060	54	0	197	18	590	3.0	<0.05	<0.05	.10	5.8	
		12-4-73	7.4			1180		376	290	147	56	0	126	15	98	2.6	0.6	<0.05	0.1	12.	
		2-8-73	7.2			1350		496	308	202	55		165	20	83	1.7		<0.05		5.9	
		31-10-73	7.2			2100		516	318	418	54		173	20	212	2.8	<0.05			9.1	
		AVG.	7.3			2048		476	306	615	56	<0.06	169	14	330	2.3	<0.02	<0.06	.1	4.5	

MINISTRY OF THE ENVIRONMENT

Table 1 Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)												Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)		
4	M ^c GRATH	11-1-72								565										4.4		
		10-4-72				1500				30					156	2.3						
		12-6-72				4510				1289					610	3.8						
		11-8-72				3420		616	283	894	54	<0.1	223	14	453	2.9		0.10	<0.1	6.9		
		26-9-72	7.2			4850		910	308	1473	58	<0.1	322	26	725	3.6	.05	<0.05	<0.1	7.7		
		22-11-72				3270		636	286	865	54	<0.1	218	22	450	2.6	<0.05	<0.05	<0.1	5.8		
		12-2-73	7.4			3210		556	284	841	52	0	190	19	472	2.3	<0.05	<0.05	<0.10	5.8		
		12-4-73				2000		28	309	396	60	0	9	1	404	1.9	<0.05	<0.05	<0.1	8.9		
		15-5-73	7.1			2000		30	299	419	60		10	1	420	1	<0.5			7.3		
		2-8-73	7.3			4400		138	331	1190	59		46	6	875	1.9	<0.05			3.8		
		31-10-73	7.3			3600		84	308	907	48		28	3	712	1.9	<0.05			5.0		
		AVG.	7.3			3276		375	301	832	56	<0.06	131	12	528	2.4	<0.11	<0.06	<0.1	6.2		

MINISTRY OF THE ENVIRONMENT

Table 1 Summary of Water Analyses

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Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)										Remarks	
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS		Nitrate (NO ₃)
5	M. G. SUMMERS	11-1-72								1120										7.2	
		11-8-72				4220		636	264	1160	73	<0.1	274	18	584	2.7		0.05	<0.1	10.0	
		26-9-72	7.4			7272		876	324	2252	64	<0.1	302	29	1190	3.6	<0.05	<0.05	<0.1	5.7	
		22-11-72				4230		92	302	1142	51	<0.1	24	8	850	3.7	<0.05	<0.05	0.1	6.4	
		12-2-73	7.8			4110		56	239	1080	47	0	12	6	800	4.4	0.15	<0.05	.10	5.0	
		15-5-73	7.3			5100		78	289	1460	48		21	6	1050	4.5	<0.05			3.7	
		1-8-73	7.1			6400		680	356	1851	64		248	14	1110	4.8	0.5			2.5	
		AVG.	7.4			5222		403	296	1438	58	<0.08	147	14	881	4.0	<0.07	<0.05	<.1	3.9	

MINISTRY OF THE ENVIRONMENT

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS		Nitrate (NO ₃)
6	J. TANSEN	12-1-72								140										3.9	
		10-4-72				1000				128					48	2.0					
		12-6-72				1100				134					46	1.8					
		1-8-73	7.3			1020		400	281	117	44		144	10	50	2.0	1.05			2.4	
		31-10-73	7.4			1020		404	296	114	44		138	15	53	2.2	1.05			4.5	
		AVG.	7.4			1035		402	289	127	44		141	13	44	2.0	1.05			3.6	

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS or LAS	Nitrate (NO ₃)			
7	K. BADHAM	12-1-72								1270										5.2			
		10-4-72				2040				504					292	2.7							
		12-6-72				3020				756					348	3.1							
		11-8-72				4610		860	297	1290	59	<0.1	316	17	596	3.9		0.10	<0.1	7.1			
		26-9-72	7.2			3490		724	324	879	64	<0.1	251	23	435	3.4	0.50	0.05	<0.1	8.6			
		12-2-73	7.3			4140		572	304	1165	59	0	197	19	690	3.7	0.50	0.05	<.1	5.1			
		12-4-73	7.4			1240		364	297	169	58	0	123	15	130	2.2	0.2	.05	0.1	11			
		15-5-73	7.2			1180		440	295	163	58		144	19	86	2.2	0.35			9.8			
		1-8-73	7.2			1850		516	305	400	59		176	18	183	2.6	<0.5			4.9			
		31-10-73	7.2			4850		648	344	1370	52		219	24	768	4.1	.10			5.3			
		AVG.	7.3			2936		589	309	796	58	<0.5	204	19	392	3.1	5.28	.06	<.1	5.9			

MINISTRY OF THE ENVIRONMENT

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
8	C.R. COWOY	12-1-72								167										5.0	
		10-4-72				1180				172					76	3.3					
		12-6-72				1889				416					164	4.2					
		11-8-72				2230		560	282	526	59	<0.1	193	18	248	4.3		0.05	<0.1	3.0	
		26-9-72	7.2			2400		584	296	531	55	<0.1	198	21	249	4.3	.10	<0.05	<0.1	4.4	
		22-11-72				1400		428	294	245	53	<0.1	136	21	140	2.4	1.1	0.70	<0.1	4.8	
		22-2-73	7.3			1540		420	286	292	61	0	141	17	165	3.4	0.20	<0.05	4.1	2.8	
		12-4-73	7.5			1560		416	220	340	46	0	138	18	150	3.6	0.2	.05	0.1	1.6	
		15-5-73	7.2			5200		716	263	1520	60		237	30	825	2.3	0.15			1.6	
		1-8-73	7.1			3700		950	271	1059	58		360	12	370	5.0	<0.5			1.6	
		31-10-73	7.2			1460		356	322	233	52		117	16	167	3.1	.25			3.7	
		AX6.	7.3			2256		554	279	500	56	<0.06	190	19	255	4.1	5.29	5.18	<0.1	3.2	

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
9	T.A. HICKS	12-1-72								113										11.0	
		10-4-72				1510			330	149	57		179	19	52	2.5				24.0	
		12-6-72				955		392	297	96	46		136	12	42	2.1				46	
		11-8-72				1040		432	286	116	52	<0.1	147	15	48	2.3		.10	<0.1	9.2	
		26-9-72	7.4			1060		428	284	119	50	<0.1	150	13	52	1.9	<0.5	<0.5	<0.1	9.9	
		12-2-73	7.3			1325		512	325	177	54	0	176	17	78	2.6	0.05	<0.05	<.1	12.	
		12-4-73	7.3			1020		420	299	120	47	0	141	17	49	1.8	<0.5	<0.5	0.1	6.1	
		15-5-73	7.2			910		400	288	103	45		133	17	37	1.7	<0.5			6.0	
		1-8-73	7.5			940		392	287	115	46		134	13	53	2.5	<0.5			3.1	
		31-10-73	7.3			990		404	297	106	44		131	18	47	2.4	<0.5			6.8	
		AVG.	7.3			972		423	333	121	49	<0.5	147	16	51	2.2	<0.5	<0.6	<0.1	9.3	

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Table / Summary of Water Analyses

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Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
10	DRENKAW	12-1-72								177										1.5	
		11-8-72				1660		496	284	325	63	<0.1	165	20	156	4.0		.10	<0.1	2.5	
		26-9-72	7.2			7030		572	288	449	61	<0.1	197	19	189	3.9	.20	.10	<0.1	2.8	
		22-11-72				962		444	296	156	58	<0.1	147	18	68	2.8	0.15	0.10	<0.1	4.2	
		12-2-73	7.5			1245		436	298	182	61	0	146	17	95	3.5	0.55	0.05	<.1	3.2	
		12-5-73	7.4			1460		400	235	296	52	0	134	16	126	3.7	0.4	0.1	<0.1	.70	
		15-5-73	7.1			4900		868	260	1440	78		285	38	680	5.4	0.20			.76	
		1-8-73	7.2			2600		664	273	667	57		213	32	285	5.0	<0.5			.44	
		31-10-73	7.2			1130		396	312	157	54		130	18	85	2.9	.10			3.1	
		AVG.	7.3			2624		535	281	428	61	<0.6	177	22	211	3.9	.24	.45	<0.1	4.0	

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Table / Summary of Water Analyses

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Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)													Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)			
12	ROYAL BANK	13-1-72								55										0.08			
		10-4-72				818				69					47	7.9							
		12-6-72				864				73					43	8.6							
		22-4-72				682		388	252	57	152	<0.1	93	37	46	7.3	0.20	0.10	<0.1	0.02			
		13-2-73	7.7			910		372	253	57	149	0	90	36	54	8.2	0.20	0.05	<0.10	0.01			
		12-4-73	7.6			900		368	356	58	160	0	85	38	54	8.2	0.3	<0.03	<0.1	0.02			
		15-5-73	7.4			820		344	252	69	100		80	35	53	8.4	0.15			0.04			
		2-8-73	7.4			850		336	262	85	71		80	34	42	7.4	0.10			0.06			
		31-10-73	7.5			870		356	263	90	60		80	38	43	7.4	0.20			0.08			
		AVG.	7.5			839		361	273	68	115	<0.3	85	36	48	7.9	0.19	<0.6	<0.1	0.04			

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS or LAS	Nitrate (NO ₃)	
.14	BLEZARD	10-4-72				1030				128					57	33					
		12-6-72				1590				314					103	3.6					
		11-8-72				1240		424	285	177	62	<0.1	142	16	73	3.0		.20	<0.1	4.5	
		26-9-72	7.4			1070		422	286	131	55	<0.1	146	14	64	2.6	.40	.10	<0.1	5.0	
		22-11-72				925		444	292	135	56	<0.1	142	21	56	2.7	0.20	0.20	<0.1	6.1	
		12-4-73	7.5			1600		604	253	343	54	0	195	28	90	3.7	0.6	0.05	0.1	2.4	
		15-5-73	7.3			3570		784	457	985	59		256	35	422	4.4	0.45			3.4	
		1-8-73	7.4			1600		742	281	311	54		154	22	139	3.4	.30			1.7	
		31-10-73	7.5			1100		384	297	144	53		126	17	86	3.0	.40			3.8	
		AVG.	7.4			1525		543	307	296	58	<0.08	166	22	121	3.3	.39	.14	<0.1	3.8	

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
15	DUNNIGAN	10-4-72				1250				239	—				67	3.7					
		12-6-72				2462				583					235	4.7					
		11-8-72				1940		500	284	415	63	<0.1	171	17	203	3.8		0.10	<0.1	1.5	
		26-4-72	7.3			3050		684	292	774	55	<0.1	226	29	335	5.3	.20	.05	<0.1	1.7	
		11-2-73	7.5			1600		404	295	306	58	0	134	17	180	2.6	0.25	<0.05	<.1	1.7	
		12-4-73	7.4			2350		524	263	570	51	0	167	26	282	6.0	0.1	0.05	0.1	3.1	
		15-5-73	7.2			3100		604	276	818	59		192	30	403	4.7	<.05			2.6	
		1-8-73	7.2			3300		648	292	908	67		213	28	440	5.0	.05			.82	
		31-10-73	7.4			1850		396	315	395	52		128	18	238	3.6	.10			1.5	
		AVG.	7.3			2322		537	288	556	58	<.05	176	24	265	4.5	<.13	0.06	<0.1	1.9	

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
16	CARLETON COUNTY	10-4-72				4600				1430					590	11.0					
		12-6-72				1055				92					81	65					
		11-9-72				1000		380	310	77	121	10.1	93	36	66	6.6		0.10	<0.1	.04	
		21-9-72	7.3			1340		452	302	195	108	10.1	117	38	106	7.2	0.35	<0.05	<0.1	.05	
		22-11-72				800		396	316	60	119	10.1	93	39	63	6.5	0.25	<0.05	<0.1	.01	
		13-2-73	7.6			905		384	316	46	118	0	91	38	58	7.4	0.30	0.05	<1.0	.01	
		12-4-73	7.5			840		372	298	43	114	0	82	41	50	7.1	0.5	<0.05	<0.1	.02	
		15-5-73	7.3			880		376	301	48	109		85	40	49	7.2	0.15			.06	
		1-8-73	7.2			2700		700	294	662	90		179	62	274	7.1	.20			.06	
		31-10-73	7.6			1140		396	322	129	95		90	42	93	7.4	.40			.06	
		AVG.	7.4			1426		432	307	278	109	<0.06	104	38	143	7.4	.31	<0.6	<0.1	.04	

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)			
17	CARLSTAN MANUFACTURING.	10-4-72				740				22					11	6.1							
		12-6-72				840				31					16	5.0							
		11-8-72				842	452	331	20	117	<0.1	123	35	12	5.6		.20	<0.1	<.01				
		26-9-72	7.3			897	448	328	43	105	<0.1	125	33	14	5.2	1.55	.20	<0.1	<.01				
		22-11-72				760	456	336	29	104	<0.1	122	36	16	5.3	2.0	0.35	<0.1	.01				
		12-2-73	7.6			830	460	329	32	122	0	126	35	11	5.9	1.7	0.20	<.1	0.01				
		12-4-73	7.4			710	336	264	55	39	0	96	23	19	2.4	0.2	.05	<0.1	.01				
		15-5-73	7.2			870	428	319	70	56		128	26	27	2.6	<.05			.94				
		1-8-73	7.3			850	424	315	62	73		130	24	21	3.4	.30			.59				
		31-10-73	7.4			730	396	305	59	54		102	34	17	4.3	1.0			.04				
		AVG.	7.4			807	425	316	42	84	<.06	119	31	16	4.6	<.97	.20	<0.1	<.20				

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Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
18	GAUVAN	10-4-72				778				79					33	4.4					
		12-6-72				896				84					33	2.4					
		11-8-72				872		376	300	77	33	<0.1	142	5	35	1.8		.25	<0.1	4.6	
		26-9-72	7.3			838		432	321	26	111	<0.1	114	36	19	6.3	.15	.15	<0.1	.29	
		22-11-72				790		452	327	60	75	<0.1	122	36	23	5.6	0.10	<0.05	<0.1	.59	
		12-2-73	7.3			890		436	327	58	59	0	118	34	24	6.1	<0.05	<0.05	<.1	.73	
		12-4-73	7.7			650		272	194	67	31	0	93	10	25	1.4	0.1	<0.05	<0.1	2.6	
		15-5-73	7.2			740		328	240	72	37		114	11	33	1.4	<0.05			4.5	
		1-8-73	7.2			840		428	312	32	115		114	36	19	5.3	<0.05			.57	
		31-10-73	7.4			700		376	288	56	55		96	33	16	5.4	<0.05			.66	
		AVG.	7.4			799		388	289	61	65	<0.06	114	25	26	4.0	<0.08	<.11	<0.1	1.82	

MINISTRY OF THE ENVIRONMENT

Table | Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)													Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)			
19	B. LACKEY	10-4-72				798				42													
		12-6-72				831				36													
		11-8-72				789		404	308	29	89	10.1	110	31	14	5.9		.30	<0.1	.41			
		26-9-72	7.4			780		400	308	24	86	<0.1	109	31	16	6.0	.55	.30	<0.1	<.01			
		22-11-72						420	289	42	82	<0.1	107	36	15	6.2	.40	.30	<0.1	1.5			
		12-2-73				795		408	285	39	87	0	105	35	15	6.6	.30	.15	.10	2.8			
		12-4-73	7.4			830		420	320	43	84	0	107	37	12	5.8	.6	.3	<0.1	.02			
		15-5-73	7.2			830		464	328	18	122		118	41	14	6.6	.65			.02			
		1-8-73	7.3			870		448	370	45	92		122	36	13	6.0	.65			.03			
		31-10-73	7.3			710		376	302	32	62		94	34	13	6.1	.75			<.01			
		AV6	7.3			804		418	309	35	88	<.06	109	35	14	5.9	.56	1.35	<0.1	<.60			

MINISTRY OF THE ENVIRONMENT

Table 1 Summary of Water Analyses

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
20	FOOD LINER	10-4-72				870				86					41	56					
		11-8-72				922		360	265	61	134	<0.1	98	28	55	5.1		.35	<0.1	1.1	
		26-4-72	7.5			998		370	289	97	85	<0.1	109	24	76	4.7	<0.5	<0.5	<0.1	1.3	
		22-11-72				880		440	258	74	190	<0.1	117	36	55	6.7	0.05	.05	<0.1	.58	
		17-2-73	7.7			1085		410	286	99	135	0	119	27	79	5.7	<0.5	<0.5	<1.0	3.1	
		12-4-73	7.4			1180		420	299	138	132	0	120	29	84	5.3	<0.5	<0.5	.1	1.7	
		15-5-73	7.3			980		364	279	84	124		101	27	78	4.8	<0.5			1.4	
		1-8-73	7.3			990		364	296	101	75		104	26	71	4.3	<0.5			1.3	
		31-10-73	7.3			1000		396	300	117	60		109	29	70	4.7	.05			1.5	
		AVG.	7.4			989		391	284	95	117	<0.6	110	28	68	5.1	<0.5	<1.1	<1.0	1.5	

MINISTRY OF THE ENVIRONMENT

Table / Summary of Water Analyses

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)			
21	MCKEOWN CLARK	10-4-72				845				53					36	63							
		12-6-72				977				52					217	23							
		11-8-72				1050		21	321	59	1.38	<0.1	<1	<1	261	0.7		<.05		.02			
		26-9-72	7.3			994		460	304	57	156	<0.1	81	62	44	6.5	.85	.15		<0.1			
		22-11-72				860		432	324	53	140	<0.1	93	48	46	7.9	.60	.40		<0.1			
		12-2-73	7.6			938		422	313	45	145	0	94	45	48	7.2	.55	.20		0.01			
		15-5-73	7.3			960		12	316	43	120		3	1	<1	<1	<.05			<.01			
		2-8-73	7.6			1000		15	336	49	126		4	1	228	.5	.10			.05			
		AVG.	7.5			953		224	319	51	114	<.08	46	26	110	3.6	.43	.40		<.05			

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
22	DEEVY	10-4-72				2190				557					355	2.8					
		12-6-72				2221				487					212	3.2					
		11-8-72				4620		830	295	1280	58	0.1	308	15	628	4.3		1.05	.3	5.5	
		26-9-72	7.2			1860		556	322	352	59	0.1	189	20	180	2.6	1.05	1.05	1.01	11.	
		13-2-73	7.4			3825		608	301	1040	57	0	208	21	555	4.2	.05	1.05	1.10	6.0	
		12-4-73	7.3			1460		496	315	229	51	0	165	20	98	2.3	0.1	1.05	1.01	12.	
		2-8-73	7.2			1460		508	311	239	49		171	20	93	2.2	1.05			5.9	
		31-10-73	7.4			2050		528	314	450	50		173	23	218	3.0	.05			8.5	
		AVG.	7.3			2461		588	310	579	54	1.05	202	20	292	3.1	1.06	1.05	1.15	8.2	

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Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
23	WALTON	10-4-72				2430				621					400	3.1					
		12-6-72				1481				222					104	2.5					
		11-8-72				4100		750	303	757	55	<0.1	264	22	342	3.7		<.05	<.01	7.1	
		26-9-72	7.2			1500		508	330	233	54	<0.1	173	18	114	2.7	.05	<.05	<.01	12	
		22-11-72				3200		552	304	830	54	<0.1	186	21	458	3.2	.25	0.20	0.1	5.5	
		12-4-73	7.4			1240		396	297	166	56	0	130	18	103	2.3	.2	<.05	<.01	12	
		15-5-73	7.2			1140		420	291	146	57		139	18	81	2.2	.10			11	
		2-8-73	7.1			1330		480	306	197	55		160	20	85	2.1	<.05			5.8	
		31-10-73	7.2			1560		512	316	261	50		170	21	122	2.6	.10			10	
		AVG.	7.2			1998		517	307	381	54	<.08	175	21	201	2.7	<.13	<.09	<.01	9.1	

MINISTRY OF THE ENVIRONMENT

Table / Summary of Water Analyses

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Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CoCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
24	BLANEY	10-4-72				3300				925					468	4.2					
		12-6-72				1090				115					77	2.5					
		11-8-72				1260		460	308	174	59	10.1	163	13	82	2.8		1.05	10.1	10	
		26-9-72	7.3			1100		412	288	124	60	10.1	138	16	68	2.1	1.05	1.05	10.1	10	
		22-11-72				2640		732	317	631	60	10.1	243	30	253	3.7	1.05	1.05	0.1	7.2	
		13-2-73	7.4			3205		680	312	841	58	0	230	25	395	4.5	1.05	1.05	10	6.5	
		12-4-73	7.4			1080		404	307	113	93	0	128	20	62	2.4	0.10	1.05	10.1	4.0	
		15-5-73	7.3			1030		400	290	115	79		128	19	73	2.4	0.10			8.1	
		31-10-73	7.4			1140		432	287	173	50		138	21	70	2.9	1.05			9.1	
		AVG.	7.4			1761		503	301	357	66	10.06	167	21	172	3.1	1.07	1.05	10.1	7.8	

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Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
26	A. SAUVE	10-4-72				1090			294	159	47		149	13	69	2.1					
		12-6-72				1485		436	280	274	46		168	4	112	2.3				3.1	
		11-8-72				1490		452	276	273	47	<0.1	158	14	117	2.4		0.15	<0.1	3.1	
		26-9-72	7.5			1700		532	272	349	44	<0.1	184	17	127	2.3	.1	1.05	<0.1	2.3	
		22-11-72				1260		424	288	217	43	<0.1	146	14	101	1.6	<0.05	<0.05	0.1	3.5	
		12-2-73	7.7			1180		400	289	171	44	0	139	13	83	2.3	0.10	<0.05	<0.10	4.1	
		12-4-73	7.3			3900		752	297	1060	50	0	253	29	486	3.7	.06	<0.05	<0.1	8.9	
		15-5-73	7.1			4750		852	307	1340	57		264	37	645	3.9	<0.05			8.4	
		1-8-73	7.2			2900		760	252	774	44		267	22	288	3.3	.20			6.1	
		31-10-73	7.4			1970		560	269	455	35		192	19	192	2.7	.05			2.7	
		AVG.	7.4			2173		573	282	507	46	<0.06	192	18	222	2.6	<0.09	<0.07	<0.1	4.7	

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)		
28	VILLAGE OF STITTSVILLE	10-4-72				2210			314	30	84		93	41	22	7.0						
		12-6-72				940		304	316	55	188		70	31	45	6.7				0.01		
		11-8-72				896		400	312	46	122	<0.1	98	38	35	7.9		0.20	<0.1	.04		
		21-9-72	7.4			990		416	288	77	110	<0.1	108	36	50	7.0	2.1	<0.5	<0.1	<0.1		
		22-11-72				750		420	34	45	107	<0.1	110	40	37	7.4	0.90	0.45	<0.1	.02		
		12-2-73	7.5			885		408	323	32	121	0	98	40	42	7.6	1.2	0.10	<1.10	.01		
		12-4-73	7.5			830		376	380	42	105	0	86	39	38	7.2	1.3	0.1	<0.1	.01		
		15-5-73	7.3			830		392	305	40	108		90	41	39	6.8	<.95			<.01		
		1-8-73	7.2			1280		516	307	194	84		130	46	67	6.3	1.1			.03		
		31-10-73	7.3			830		380	308	44	79		88	39	29	7.3	.95			.07		
		AVG.	7.4			1044		401	289	61	111	<.06	97	39	40	7.1	1.21	.18	<0.1	.02		

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)		
29	B. HAW	10-4-72				3460			320	323	57		197	23	128	35						
		12-6-72				1082		324	283	123	80		102	16	66	2.1				4.8		
		26-9-72	7.3			1050		402	322	86	64	10.1	113	29	57	6.0	.05	1.05	10.1	.49		
		15-5-73	7.3			1060		436	291	120	110		136	23	66	2.9	1.05			4.0		
		2-8-73	7.2			1130		448	298	114	98		136	26	58	2.1	1.05			1.5		
		31-10-73	7.4			1040		424	304	102	82		128	25	67	3.0	.05			7.1		
		AVG.	7.3			1470		407	303	145	82	10.1	135	24	74	3.3	1.05	1.05	10.1	3.6		

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
30	THAYER	10-4-72				1500			274	494	67		142	3	301	2.4					
		12-6-72				2998		664	289	760	63		220	27	355	3.4				4.2	
		11-8-72				5130		910	304	1470	60	10.1	320	24	692	4.3		0.20	<0.1	2.4	
		26-9-72	7.2			4660		832	319	1292	76	<0.1	291	25	690	3.7	1.05	.10	<0.1	4.6	
		22-11-72				4030		744	304	1235	61	<0.1	262	21	680	3.2	.15	.16	<0.1	5.4	
		13-2-73	7.5			4440		650	302	1250	57	0	229	19	675	4.5	.10	<0.05	.10	5.5	
		15-5-73	7.1			1500		540	313	261	53		178	23	102	2.3	.75			12	
		2-8-73	7.3			1850		504	310	299	58		163	24	137	2.7	.10			2.4	
		31-10-73	7.2			4050		584	338	1160	39		197	22	690	3.7	.15			5.5	
		AVG.	7.3			3351		679	306	913	59	<0.8	222	21	479	3.4	.38	.11	<0.1	3.9	

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										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
31	BOATES	10-4-72				3460				980					450	4.1					
		12-6-72				1295				173					100	2.4					
		11-8-72				1600	530	323		265	58	10.1	192	12	136	2.4		0.20	10.1	11	
		26-9-72	7.4			1320	480	320		180	56	10.1	162	18	82	2.4	1.05	1.05	10.1	11	
		12-2-73	7.4			3480	616	308		906	57	0	211	21	510	3.1	.10	1.05	.10	5.8	
		12-4-73	7.3			1040	380	279		106	72	0	120	19	84	2.6	1.05	1.05	10.1	10	
		15-5-73	7.3			1110	412	289		141	60		138	17	84	2.1	0.15			10	
		2-8-73	7.3			980	360	272		96	59		117	16	58	1.8	1.05			5	
		31-10-73	7.6			1400	500	309		213	52		158	25	91	2.6	1.05			10	
		AV6.	7.4			1743	468	300		340	59	10.5	157	18	177	2.6	1.08	1.09	10.1	9.0	

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Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)										Remarks	
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS		Nitrate (NO ₃)
32	JEFFREY	10-4-72				1120				191					90	19					
		12-6-72				3560				960					435	3.2					
		11-8-72				2500		484	292	579	49	<0.1	178	11	316	2.4		0.25	<0.1	4.7	
		26-9-72	7.2			5720		780	310	1637	63	<0.1	280	19	350	3.6	.05	<0.05	<0.1	4.9	
		12-2-73	7.4			1870		432	267	423	47	0	150	14	218	2.4	.10	<0.05	<0.1	4.8	
		12-4-73	7.3			2850		468	219	770	47	0	160	17	400	2.9	.10	<0.05	<0.1	2.5	
		15-5-73	7.3			3650		500	257	1010	49		173	17	565	3.2	0.05			3.2	
		1-8-73	7.1			5200		660	309	1536	65		234	18	855	3.5	<0.05			2.3	
		31-10-73	7.3			3650		476	335	993	40		160	18	608	3.0	.05			5.4	
		AVG.	7.3			3347		543	284	900	51	<0.05	191	16	426	4.7	.07	<0.10	<0.1	4.0	

MINISTRY OF THE ENVIRONMENT

Table / Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS or LAS	Nitrate (NO ₃)	
33	KAVANAGH	10-4-72				1090				179					80	19					
		12-6-72				2665				763					336	2.4					
		11-8-72				1190		404	280	184	43	<0.1	149	8	86	1.9		.15	<0.1	4.6	
		26-9-72	7.3			2810		560	296	715	44	<0.1	198	16	354	2.4	<0.5	<0.5	<0.1	5.7	
		22-11-72				1360		420	283	246	44	<0.1	146	13	123	1.5	.10	<0.5	<0.1	5.4	
		12-2-73	7.5			1860		16	273	395	43	0	4	1	402	1.8	<0.5	<0.5	<0.1	5.0	
		12-4-73	7.6			3400		24	229	96	42	0	8	1	695	1.1	<0.5	<0.5	<0.1	2.6	
		15-5-73	7.4			3700		348	265	1030	47		109	18	640	2.9	<0.5			3.2	
		1-8-73	7.2			5400		72	311	1689	64		27	1	1190	1.6	<0.5			2.1	
		31-10-73	7.4			1800		104	331	350	41		34	4	338	1.5	<0.5			5.6	
		AVG.	7.4			2528		244	284	565	46	<0.6	84	8	424	1.9	<0.6	<0.7	<0.1	4.3	

MINISTRY OF THE ENVIRONMENT

Table 1. Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
34	P. JANSEN	10-4-72				1070				149					61	1.8					
		12-6-72				999				141					61	1.5					
		11-8-72				973		372	263	122	44	10.1	131	11	58	1.5		.10	<0.1	4.6	
		26-9-72	7.5			959		364	254	123	37	<0.1	126	12	57	1.4	.10	.05	<0.1	5.7	
		22-11-72				982		400	276	124	89	<0.1	136	14	55	1.0	.05	.05	<0.1	5.4	
		12-2-73	7.5			960		380	271	115	40	0	131	13	52	1.8	.15	.05	<.1	5.1	
		12-4-73	7.4			1200		440	232	209	38	0	146	18	69	1.7	.10	.05	<0.1	5.3	
		15-5-73	7.3			2700		120	242	708	43		242	27	258	2.5	.10			4.4	
		1-8-73	7.3			2350		464	267	565	41		163	13	295	2.3	.05			2.3	
		31-10-73	7.4			1060		344	263	153	36		117	13	85	2.0	.05			4.0	
		AVG.	7.4			1325		434	259	241	46	.06	149	15	105	1.8	.09	.06	<0.1	4.6	

MINISTRY OF THE ENVIRONMENT

Table / Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS at LAS	Nitrate (NO ₃)	
35	KRUGER	12-6-72				4590		664	260	1341	56		230	21	660	5.1				3.3	
		22-11-72				3000		452	280	759	56	10.1	150	18	471	28	1.1	0.70	10.1	4.0	
		12-2-73	7.3			2890		428	274	734	53	0	147	15	464	36	1.6	.15	1.1	3.4	
		12-4-73	7.5			3800		532	234	1076	51	0	180	19	600	3.2	0.6	0.2	0.1	1.7	
		15-5-73	7.3			4800		588	270	1400	59		198	22	775	6.4	.80			2.5	
		1-8-73	7.3			5100		564	214	1671	69		131	58	895	5.3	1.8			10.1	
		31-10-73	7.3			4000		488	331	1150	37		166	18	705	4.0	.50			3.6	
		AVG.	7.3			4025		531	266	1161	54	10.3	172	24	653	4.3	1.1	.35	1.1	2.6	

MINISTRY OF THE ENVIRONMENT

Table / Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)												Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)		
36	MARTIN	11-8-72				2230		616	248	514	45	<0.1	216	18	208	2.3		0.10	<0.1	8.9		
		26-9-72	7.4			2860		768	266	727	45	<0.1	261	28	260	2.7	<0.05	<0.05	<0.1	10.		
		22-11-72				2100		652	273	564	47	<0.1	221	24	248	1.1	<0.05	<0.05	<0.1	8.5		
		2-8-73	7.3			3000		752	286	789	53		250	32	286	2.9	<0.05			6.3		

Table / Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
37	THOMAS	11-8-72				2880		504	293	746	82	<0.1	176	25	404	5.4		.10	<0.1	.82	
		26-9-72	7.1			5370		940	304	1528	62	<0.1	296	48	785	8.1	.25	<.05	<0.1	1.6	
		22-11-72				1860		340	309	415	81	<0.1	99	22	318	5.6	.20	<.05	<0.1	1.0	
		12-2-73	7.3			2150		376	299	474	78	0	112	23	312	5.8	.20	.10	<.1	1.1	
		12-4-73	7.5			2300		440	250	564	89	0	127	30	314	7.4	.2	.1	<0.1	.24	
		15-5-73	7.3			3050		584	255	800	82		165	37	418	7.3	.20			.70	
		1-8-73	7.2			5300		792	305	1550	82		248	42	770	7.8	.20			.93	
		AVG.	7.3			3367		565	288	868	79	<.06	189	32	474	6.8	.21	<.08	<0.1	.91	

MINISTRY OF THE ENVIRONMENT

Table Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
38	F. PAFINETTI	11-8-72				1010		388	290	101	97	<0.1	107	31	64	5.4		.10	<0.1	.58	
		26-9-72	7.5			1040		392	306	103	84	<0.1	9	35	79	5.6	.15	<.05	<0.1	2.5	
		12-2-73	7.5			915		380	296	69	94	0	99	32	53	5.3	0.10	<.05	<1	1.0	
		1-8-73	7.3			1820		672	268	389	87		157	68	107	7.5	.25			.15	
		AVG.	7.4			1196		458	290	166	91	<.07	115	42	76	6.0	.17	<.07	<0.1	1.06	
39	BEDWELL	11-8-72				1010		408	284	114	57	<0.1	146	11	53	2.3		.10	<0.1	7.4	
		26-9-72	7.3			999		408	280	108	46	<0.1	144	12	53	1.7	<.05	<.05	<0.1	6.8	
		12-4-73	7.4			1090		444	295	131	45	0	152	16	56	1.9	.10	<.05	<.1	7.1	
		1-8-73	7.2			940		364	283	100	42		133	8	47	1.8	.05			2.1	
		AVG.	7.3			1010		406	286	113	48	<.07	144	12	52	1.9	<.07	<.07	<0.1	5.9	

MINISTRY OF THE ENVIRONMENT

Table Summary of Water Analyses

Prepared by

Source and Number	Location	Date Sampled	pH	Colour Hazen Units	Turbidity Jackson Units	Specific Conductance mmhos at 25°C	Total Dissolved Solids (ppm)	Total Hardness as CaCO ₃ (ppm)	Alkalinity as CaCO ₃ (ppm)	Chemical Constituents in parts per million (ppm)											Remarks
										Chloride (Cl)	Sulphate (SO ₄)	Sulphide (H ₂ S)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Total Iron (Fe)	Soluble Iron (Fe)	MBAS as LAS	Nitrate (NO ₃)	
40	HOLLY	11-8-72				3930		676	286	1120	53	<0.1	241	17	620	4.4		0.10	<0.1	4.6	
		26-9-72	7.3			6230		1020	314	1807	64	<0.1	344	38	895	5.0	.05	<0.05	<0.1	4.9	
		22-11-72				2550		376	292	617	51	<0.1	128	13	414	2.5	<0.05	<0.05	<0.1	5.2	
		1-8-73	7.2			5200		716	331	1510	65		248	24	784	3.6	.10			2.5	
		AVG.	7.25			4478		697	306	1264	58	<0.1	240	23	678	4.1	.07	.07	<0.1	4.3	
41	LINSENMIER	11-8-72				3630		790	301	994	46	<0.1	304	7	425	3.0		0.10	<0.1	8.0	
		28-2-73					2972	770		1500	62				851						
		12-4-73	7.2			4306		784	340	1186	56	0	254	37	560	3.8	0.1	.05	.05	6.2	
		15-5-73	7.1			3550		712	335	922	53		234	31	470	3.1	<0.05			9.2	
		2-8-73	7.1			3200		636	339	812	64		203	32	412	2.8	<0.05			5.1	
		AVG.	7.1			3670	2912	738	329	1083	56	.05	249	27	544	3.2	.07	.08	<0.1	7.1	

MINISTRY OF THE ENVIRONMENT

Table Summary of Water Analyses

Prepared by

[illegible]

Area of Survey STITTSVILLE

ONTARIO WATER RESOURCES COMMISSION
CHEMICAL BALANCE OF IONIC EQUIVALENTS

TABLE 2 Page 1 of 2Date Sept. 26 1972

CATIONS																									ANIONS									
Ion	Ca			Mg			Na			K			Na+K	Total Cations	Alk as CaCO ₃			SO ₄			Cl			Total Anions	Diff %									
Conversion Factor	ppm x .0499			ppm x .0822			ppm x .0435			ppm x .0256					HCO ₃ ppm x .0200	CO ₃ ppm x .5994	ppm x .0208			ppm x .0282														
Well No.	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%	/o	epm	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm										
1 MILLER	361	18.0	30.6	32	2.6	4.4	890	38.7	65.8	3.8	0.1	0.2	66.0	59.4	336	6.7	11.4	65	1.4	2.4	1822	51.4	87.4	595	0.2									
3 CRABBE	179	8.9	55.2	20	1.6	9.9	126	5.5	34.1	2.5	0.1	0.6	34.7	16.1	332	6.6	42.6	55	1.1	7.1	277	7.8	50.3	155	3.9									
4 MCGRATH	322	16.1	32.3	26	2.1	4.2	725	31.5	63.3	3.6	0.1	0.2	63.5	49.8	308	6.2	12.7	58	1.2	2.5	1473	41.5	84.9	48.9	1.8									
5 SUMMERS	302	15.1	21.8	29	2.4	3.5	1190	51.8	74.6	3.6	0.1	0.1	74.7	69.4	324	6.5	9.1	64	1.3	1.8	2252	63.5	89.1	71.3	2.7									
7 BADHAM	251	12.5	37.4	23	1.9	5.7	435	18.9	56.6	3.4	0.1	0.3	56.9	33.4	324	6.5	19.9	64	1.3	4.0	879	24.8	76.1	32.6	2.5									
8 COWDY	198	9.9	44.0	21	1.7	7.6	249	10.8	48.0	4.3	0.1	0.4	48.4	22.5	296	5.9	26.8	55	1.1	5.0	531	15.0	68.2	22.0	2.3									
9 HICKS	150	7.5		13	1.1		52	2.3		1.9	0.1			11.0	284	5.7		50	1.0		119	3.4		10.1	8.9									
10 ORENNAN	197	9.8	49.7	19	1.6	8.1	189	8.2	41.6	3.9	0.1	0.5	42.1	19.7	298	5.8	29.3	61	1.3	6.6	449	12.7	64.1	19.8	0.5									
11 THORSTEN - SENWALL	250	12.5	37.0	21	1.7	5.0	448	19.5	57.7	3.2	0.1	0.3	58.0	33.8	290	5.8	17.0	58	1.2	3.5	965	27.2	79.5	34.2	1.2									
14 BLIZARD	146	7.3		14	1.2		64	2.8		2.6	0.1			11.4	286	5.7		55	1.1		131	3.7		10.5	8.6									
15 DUNNIGAN	226	11.3	39.8	29	2.4	8.5	335	14.6	51.4	5.3	0.1	0.4	51.8	28.4	292	5.8	20.2	55	1.1	3.8	774	21.8	76.0	28.7	1.0									
16 CARLETON COUNTY	117	5.8	42.3	38	3.1	22.6	106	4.6	33.6	7.2	0.2	1.5	35.1	13.7	302	6.0	43.8	108	2.2	16.1	195	5.5	40.1	13.7	0.0									
17 CARLSTAN MFG.	125	6.2	64.5	33	2.7	28.2	14	0.6	6.2	5.2	0.1	1.0	7.2	9.6	328	6.6	66.0	105	2.2	22.0	42	1.2	12.0	10.0	4.0									
18 GAUVAN	114	5.7	58.8	36	3.0	30.9	19	0.8	8.2	6.3	0.2	2.1	10.3	9.7	321	6.4	68.1	111	2.3	24.5	26	0.7	7.5	9.4	3.2									
19 LUCKEY	109	5.4	60.7	31	2.6	29.2	16	0.7	7.9	6.0	0.2	2.2	10.1	8.9	308	6.2	71.2	86	1.8	20.7	24	0.7	8.5	8.7	2.3									

[Total Hardness as ppm CaCO₃ - (ppm Ca x 2.497)] x .243 = ppm MgBicarbonate alkalinity (HCO₃) as ppm CaCO₃ x 1.22 = ppm HCO₃ as HCO₃CO₃ as ppm CO₃ x .0333 = epm CO₃HCO₃ as ppm HCO₃ x .0164 = epm HCO₃

ONTARIO WATER RESOURCES COMMISSION

Area of Survey STITTSVILLE

CHEMICAL BALANCE OF IONIC EQUIVALENTS

TABLE 2

Page 2 of 2
Date Sept. 26 19 72

CATIONS															ANIONS										
Ion Conversion Factor	Ca			Mg			Na			K			Na+K	Total Cations	Alk as CaCO ₃			SO ₄			Cl			Total Anions	Diff %
	ppm x .0499			ppm x .0822			ppm x .0435			ppm x .0256					HCO ₃ ppm x .0200 CO ₃ ppm x .5994	ppm x .0208			ppm x .0282						
Well No.	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%	%	epm	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	
22 DEEVEY	189	9.4	49.7	20	1.6	8.5	180	7.8	41.2	2.6	0.1	0.5	41.7	18.9	322	6.4	36.6	59	1.2	6.9	352	9.9	56.6	17.5	2.3
23 WALTON	173	8.6	56.6	18	1.5	9.9	114	5.0	32.9	2.7	0.1	0.6	33.2	15.2	330	6.6	46.2	54	1.1	7.7	233	6.6	46.2	14.3	6.3
24 ELFNEY	138	6.9	61.0	16	1.3	11.5	68	3.0	26.5	2.1	0.1	0.9	27.4	11.3	288	5.8		60	1.2		124	3.5		10.5	7.6
25 SAUVE	184	9.2	56.9	17	1.4	8.6	127	5.5	34.0	2.3	0.1	0.6	34.6	16.2	272	5.4	33.6	44	0.9	5.6	349	9.8	60.9	16.1	0.6
27 GALE	250	12.5	36.2	25	2.1	6.1	456	19.8	57.4	3.4	0.1	0.3	57.7	34.5	310	6.2	18.6	62	1.3	3.9	909	25.6	76.4	33.1	4.2
30 THAYER	291	14.5		25	2.1		690	30.0		3.7	0.1			46.7	319	6.4		76	1.6		1292	36.4		44.4	5.2
31 BOATES	162	8.1		18	1.5		82	3.6		2.4	0.1			13.4	320	6.4		56	1.2		180	5.1		12.7	5.5
32 JEFFREY	280	14.0	26.6	19	1.6	3.4	850	37.0	70.2	3.6	0.1	0.2	70.4	52.7	310	6.2	11.5	63	1.3	2.4	1637	46.2	86.0	53.7	1.9
35 KELVANISH	198	9.9	37.0	16	1.3	4.9	354	15.4	57.6	2.4	0.1	0.4	58.0	26.7	296	5.9	21.8	44	0.9	3.3	715	20.2	74.8	27.0	1.1
36 MARTIN	261	13.0	48.6	28	2.3	8.6	260	11.3	42.4	2.7	0.1	0.4	42.8	26.7	266	5.3	19.8	45	0.9	3.4	727	20.5	76.8	26.7	0.0
37 THOMAS	296	14.8	27.8	48	4.0	7.5	785	34.2	64.2	8.1	0.2	0.4	64.6	53.2	304	6.1	12.1	62	1.3	2.6	1528	43.1	85.3	50.5	5.3
40 HOLLY	344	17.2	29.0	38	3.1	5.2	895	38.9	65.6	5.0	0.1	0.2	65.8	59.3	314	6.3	10.7	64	1.3	2.2	1807	51.0	87.0	58.6	1.2

[Total Hardness as ppm CaCO₃ - (ppm Ca x 2.497)] x .243 = ppm Mg
Bicarbonate alkalinity (HCO₃) as ppm CaCO₃ x 1.22 = ppm HCO₃ as HCO₃

CO₃ as ppm CO₃ x .0333 = epm CO₃
HCO₃ as ppm HCO₃ x .0164 = epm HCO₃

133 Dalton Avenue, Box 820, Kingston, Ontario K7L 4X6
Tel: 549-4000

M E M O R A N D U M

September 17th, 1981

TO: P.R. Moore, Evaluator
Approvals & Planning
Technical Support

FROM: D.R. Kearney
Hydrogeologist Assistant
Technical Support

RE: Development Potential of
Ontario Hydro Holdings on Baptiste Lake
Lots 5, 6 & 7, Concs. IV, V & VI, Herschel Township

Our records show only one water well record for the entire area of interest. This drilled well is located in Lot 6, Concession IV. Yielding fresh water at a respectable rate of 450 litres per minute, the 15.6-metre deep well encountered water at 7.6 metres below ground surface, and had a static level of 3.0 metres below ground surface. There are few drilled wells on record in this area because dug or driven (sandpoint) wells are usually adequate. A review of the 99 water well records on file for the whole Township reveal the following data:

<u>Water Quality</u>	<u>Number of Wells</u>
Fresh	103
Sulphurous or Salty	0
Dry	2
Untested	6
<u>Depth to Water</u>	
Less than 7.6 metres	3
7.6 to 14.9 metres	21
15.2 to 22.9	29
23.2 to 30.2	23
30.5 to 45.7	27
46.0 to 61.0 metres	5
Greater than 61.3 metres	6
<u>Pumping Rate</u>	
Less than 13.5 litres per minute	34
13.5 to 27.0 litres per minute	27
31.5 to 54.0 litres per minute	19
Greater than 54 litres per minute	14

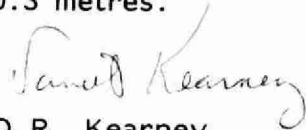
(It should be noted that the figures do not add up to 99 due to missing data for the pumping rates, and more than one water-bearing strata per well for water quality and depth to water).

Overburden in the area is reported on the well records as almost exclusively sandy. There is some hardpan clay and gravel encountered between the sandy soil and the granitic bedrock. Ontario Soil Survey #27 maps the township as mostly a Rockland complex (outcrop and sandy loam, muck in depressions). Well-drained Monteagle Sandy Loam comprises much of the eastern third of the township.

Geological maps show that the bedrock is primarily hybrid granite gneiss, migmatite and granite pegmatite, for most of the Township, with a wide band of crystalline limestone or dolomite traversing the township from east to west including most of the bottom half of Baptiste Lake.

In summary fresh water is common to the township. No saline or sulphurous aquifers are reported. The majority of drilled wells are terminated in granitic bedrock, but many wells are terminated in the overburden. Pumping rates tend to be low. Dry holes are rare. Groundwater may be anticipated from 8 to 46 metres in depth.

If water wells are contemplated, it is recommended that these wells be cased and grouted to a minimum depth of 6.0 metres to prevent contamination from surface water and/or septic tank effluent. Where bedrock is encountered at depths greater than 6.0 metres casings should be extended and adequately sealed into the bedrock to a minimum depth of 0.3 metres.



D.R. Kearney
/ck

cc: M. German
- D. Kearney
- R.F. GW 02-09 Herschel Township



(15980)

MOE/STI/SAL/APJG

MOE/STI/SAL/APJG Stillville
Campbell, F
Salt contamination
of private well water apjg
Supplies c.1 a aa